

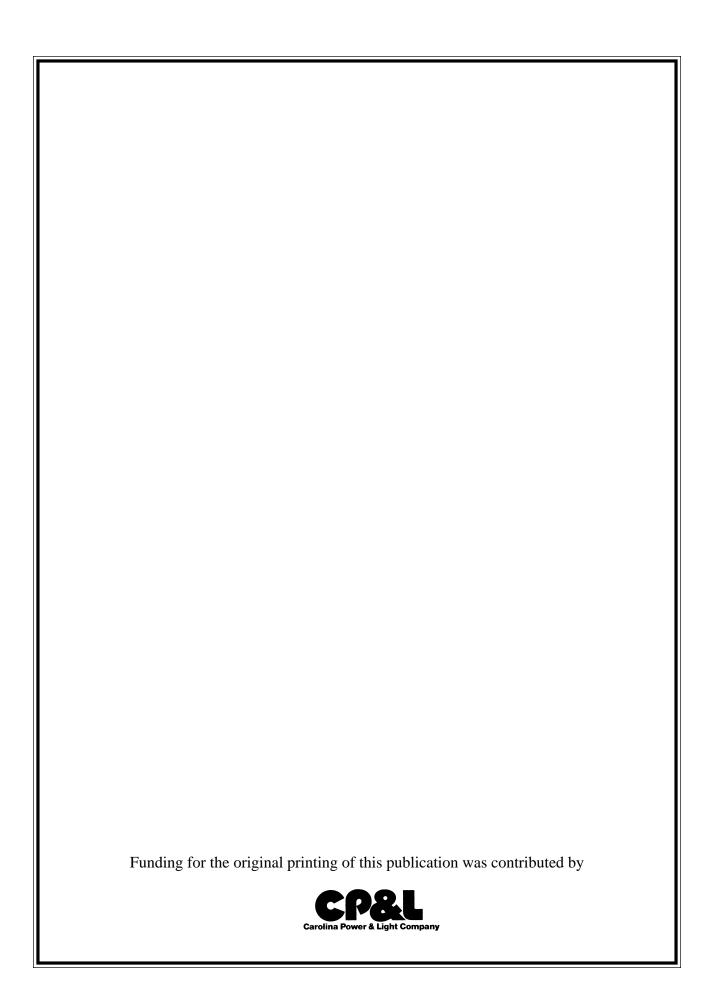


Eno River State Park

An Environmental Education Learning Experience

Designed for the Middle Grades

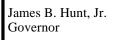
out life, there wo . Without water	
- David Quammen, A Sidelong View of S	Natural Acts, Science and Nature
A sinciong view of s	Science and Ivalure



This Environmental Education Learning Experience was developed by

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N.C. Division of Parks and Recreation Department of Environment and Natural Resources





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The N.C. Division of Water Resources;

The N.C. Department of Environment and Natural Resources;

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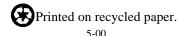


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Introduction to the North Carolina State Parks System

reserving and protecting North Carolina's natural resources is actually a relatively new idea. The seeds of the conservation movement were planted early in the 20th century when citizens were alerted to the devastation of Mount Mitchell. Logging was destroying a well-known landmark the highest peak east of the Mississippi. As the magnificent forests of this mile-high peak fell to the lumbermen's axe, alarmed citizens began to voice their opposition. Governor Locke Craig joined \ them in their efforts to save Mount Mitchell. Together they convinced the legislature to pass a bill establishing Mount Mitchell as the first state park.

That was in 1915. The North Carolina State Parks System has now been established for more than threequarters of a century. What started out as one small plot of public land has grown into 61 properties across the state, including parks, recreation areas, trails, rivers, lakes and natural areas. This vast network of land boasts some of the most beautiful

scenery in the world and offers endless recreation opportunities. But our state parks system offers much more than scenery and recreation. Our lands and waters contain unique and valuable archaeological, geological and biological resources that are an important part of our natural heritage.

na's principal conservation agencies, the Division of Parks and Recreation is responsible for the more than 167,000 acres that make up our state parks system. The Division manages these resources for the safe enjoyment of the public, and protects and preserves them as a part of the heritage we will pass on to generations to come.

An important component

As one of North Caroli-

An important component of our stewardship of these lands is education. Through our interpretation and environmental education services, the Division of Parks and Recreation strives to offer enlightening programs that lead to an understanding and appreciation of our natural resources. The goal of our environmental education program is to generate an awareness in all individuals which cultivates responsible stewardship of the earth.

For more information contact:

N.C. Division of Parks and Recreation 1615 Mail Service Center Raleigh, N.C. 27699-1615 919/733-PARK Website-www.ncsparks.net

Introduction to Eno River State Park

7 fforts to establish Eno River State Park began in 1965 when the city of Durham proposed building a reservoir on the Eno. In response, a group of concerned citizens formed the Association for the Preservation of the Eno River Valley. The Association was successful in gaining community support for its proposal that a state park be established along the river. In May of 1972, the state of North Carolina approved the idea, and the city of Durham withdrew its plans to construct the reservoir. By 1975, 1,100 acres of land had been acquired with the help of the Association, the Nature Conservancy and the Division of Parks and Recreation. Today the park protects 11 miles of river and over 2,800 acres of associated land in Orange and Durham counties.

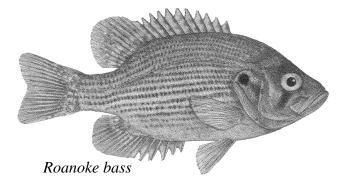
Life in and along the Eno River

Eno River State Park provides important habitat for a host of animals and plants. A mixture of steep rocky ridges and bottomlands creates several distinct plant communities. Many of the wildflowers and shrubs found in the park are normally found in the mountains and foothills of North Carolina. Shrubs, including mountain laurel and Catawba rhododendron, and wildflowers, such as yellow lady's slipper, showy orchids and wild geranium, find suitable habitat in the river valley.

The river hosts more than 61 species of fish. The Carolina madtom (a catfish) and the Roanoke bass (a game fish) appear in the Natural Heritage Program List of the Rare Animal Species of North Carolina.

Numerous macroinvertebrates are also found in the river. The tiny panhandle pebblesnail, listed as "significantly rare," is found only in the Eno River. Freshwater mussels include several endangered or threatened species such as the yellow lampmussel, Atlantic pigtoe and green floater. These and other aquatic macroinvertebrates can be used as indicator species to monitor water quality. The presence or absense of these wonderfully adapted creatures tells us much about the health of our river.

Presently, water quality in the Eno River is good. The river is classified as a public water supply and is also suitable for swimming, fishing and wading. Continuing development and water withdrawals upstream give cause for concern about the river's quality. Only through sustained vigilance and protection efforts can the river's water quality be preserved.



The Freshwater Fishes of North Carolina. © 1991 Edward F. Menhinick. Reprinted by permission.



Carolina madtom

Introduction to the Activity Packet for Eno River State Park

NOTE: Weather and river conditions permitting, on-site activities will be held on the banks of the river and in the river. Students will wade in shallow rocky areas. They should dress appropriately (long pants and tennis shoes) and bring a change of clothing. The students may encounter ticks, poison ivy and snakes, although this is not likely as long as students stay in appropriate areas. Chemical reagents are used in water quality testing. Because misuse of these chemicals can be hazardous, standard chemical protection procedures will be required. Goggles and rubber gloves will be provided for all students handling testing kits. These must be worn at all times during test procedures. The educator will assist in seeing that all safety precautions are followed. It is also the responsibility of the educator to be aware of special considerations, medical needs, etc. of participants and be prepared to take appropriate precautionary measures. Park staff should be informed of any special considerations prior to the group's arrival at the park.

he environmental education learning experience, Living Water, was developed to provide hands-on environmental education activities for the classroom and the outdoor setting of Eno River State Park. This educator's activity packet, designed to be implemented in grades 6-8, meets established curriculum objectives of the North Carolina Department of Public Instruction. Three types of activities are included:

- 1) pre-visit activities
- 2) on-site activities
- 3) post-visit activities

On-site activities will be conducted at the park, while pre-visit and post-visit activities are designed for the classroom environment. Pre-visit activities should be introduced prior to the park visit so that students will have the necessary background and vocabulary for the on-site activities. We encourage you to use the

post-visit activities to reinforce concepts, skills and vocabulary learned in the pre-visit and onsite activities.

These activities may be performed independently or in a se-

ries to build upon the students' newly gained knowledge and experiences.

The environmental education learning experience, *Living Water*, will expose the student to the following major concepts:

- Water Quality
- Indicator Species
- Water Testing
- Watershed
- River Basin
- Point and Nonpoint Source Pollution
- Aquatic Macroinvertebrates
- Aquatic Food Webs
- Natural Resource Management
- Stewardship

The first occurrence of a vocabulary word used in these activities is indicated in **bold type**. Their definitions are listed in the back of the activity packet. A list of the reference materials used in developing the activities follows the vocabulary list.

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Activity Summary

The following outline provides a brief summary of each activity, the major concepts introduced and the objectives met by completion of the activity.

I. Pre-Visit Activities

***1 Map Trivia** (page 3.1.1)

Using a transportation map and river basin map, students will learn that the Eno River watershed is part of the Neuse River Basin. They will trace the river from its headwaters to the ocean and identify key geographic locations, as well as potential point and nonpoint sources of pollution.

Major Concepts:

- River basin
- Watersheds
- Point and nonpoint pollution

Learning Skills:

- Observing, communicating, inferring
- Reading and interpreting maps
- Estimating distances

Objectives:

- Interpret and use the legends on the North Carolina state transportation map to answer five questions.
- Locate five geographic locations within the Neuse River watershed.
- Identify potential sources of point and nonpoint pollution in the Neuse River Basin.

***2 The Key to Water Quality** (page 3.2.1)

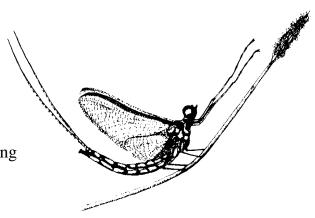
The students will practice using dichotomous keys to identify unknown tree leaves and macroinvertebrates found in the Eno River. Students will learn that macroinvertebrates are important indicators of water quality.

Major Concepts:

- Dichotomous key
- Indicator species
- Water quality
- Aquatic food webs

Learning Skills:

- Observing, classifying and communicating
- Reading taxonomic keys



Objectives:

- Use simple dichotomous keys to identify pictures of ten unknown leaves and five unknown macroinvertebrates.
- Name at least two aquatic macroinvertebrates that are tolerant of pollution and two that are intolerant of pollution.
- Give at least two reasons why macroinvertebrates are important to humans.

II. On-Site Activities

***1 Go with the Flow** (page 4.1.1)

Get wet while taking physical measurements of the river. Students will use their measurements to calculate water flow in the Eno River.

Major Concepts:

- Water flow
- Water quality
- Natural and human influences on water flow
- Aquatic habitats

Learning Skills:

- Observing, using numbers, collecting data in the field
- Measuring, averaging numbers, calculating water flow

Objectives:

- Calculate the rate of water flow using measurements and a mathematical formula.
- List three human actions that affect water flow.
- List three natural influences on water flow.
- Describe the important relationship between water quantity and quality.
- Describe three problems that can result from river water quantity extremes.
- Describe three problems that can result from river water quality changes.
- Discuss at least two things people can do to help protect rivers and water quality.

***2 Mind Your p's and H's - The Power of Hydrogen** (page 4.2.1)

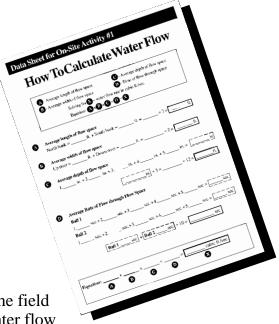
Learn to measure pH by using hands-on methods to determine the pH values of several different liquids including water from the Eno River.

Major Concepts:

- Water quality
- pH range (acid-neutral-base)
- Acid precipitation

Learning Skills:

- Observing, classifying
- Reading informational materials with complex vocabulary
- Expanding on information



Objectives:

- Demonstrate the use of litmus paper and the LaMotte test kit for determining pH.
- Find the pH of at least three common substances.
- List two natural influences that can affect the pH rating of a river.
- List two human influences that can affect the pH rating of a river.
- State the North Carolina Environmental Management Commission pH range for aquatic macroinvertebrates (6.0-9.0).

***3 Sediment: The "S" Word** (page 4.3.1)

Through a simple experiment, students will learn one method of measuring sediment. Using what they observe, students will discuss where sediment comes from, how it affects water quality, and ways to control sediment.

Major Concepts:

- Water quality
- Sediment
- Sedimentation
- Water pollution

Learning Skills:

- Observing, inferring and predicting
- Reading technical information and expanding on ideas

Objectives:

- Demonstrate how to measure sediment levels using the Imhoff cones.
- Describe three ways sediment affects aquatic life.
- List three origins of sediment and three possible ways to control the level of sediment in the river.
- List the most important causes of stream degradation in North Carolina today.

***4 Water Bugs** (page 4.4.1)

Get wet, have fun, and learn while doing it. Students will use different methods to collect and identify aquatic organisms.

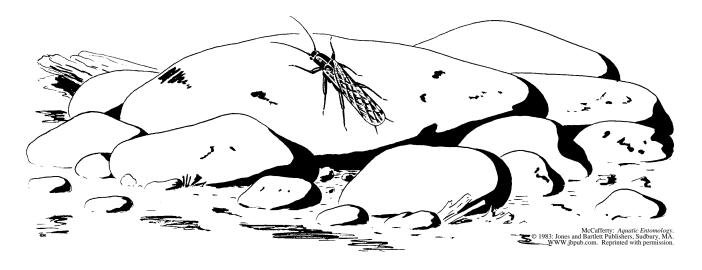
Major Concepts:

- Water quality
- Indicator species
- Adaptations
- Ecosystem
- Energy flow

Learning Skills:

- Observing, using numbers, classifying, inferring and predicting
- Reading informational materials; using keys and identification guides
- Calculating stream index values

McCafferty: Aquatic Entomology.
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Objectives:

- Describe three characteristics of aquatic macroinvertebrates that help them survive in aquatic habitats.
- Using keys and field guides, identify three macroinvertebrates in the field.
- Name three indicator species and explain how they are used to determine water quality.
- Calculate the stream index rating for a river.
- List and describe five factors necessary for a healthy river ecosystem.

III. Post-Visit Activities

#1 Fragile Waters (page 5.1.1)

Using a topographic map and land use cutouts, students will make decisions about the development of a portion of the Eno River's watershed.

Major Concepts:

- River basin
- Water quality
- Land use planning
- Resource management

Learning Skills:

- Observing, communicating and predicting
- Problem solving, respecting differences, working in groups
- Expanding on ideas, recognizing bias and persuasive techniques

Objectives:

- List two animal species endemic to the Neuse and Tar river watersheds.
- Evaluate the effects of different imaginary land uses on the Eno River watershed.
- List and discuss five ways to minimize damaging effects in the Eno River watershed.
- Balance the need to protect water quality with economic and other concerns while working with a group to arrange land use cutouts on a map.
- Give at least two examples of how air and water quality are connected.

***2 Troubled Waters** (page 5.2.1)

After reading a story about the discovery made by two young river enthusiasts, students will create their own ending. Optionally, the class can develop an action plan to correct an aquatic pollution problem in their community.

Major Concepts:

- Water pollution
- Environmental issues
- Stewardship
- Environmental sustainability

Learning Skills:

- Communicating, inferring, predicting
- Problem solving
- Creative writing

Objectives:

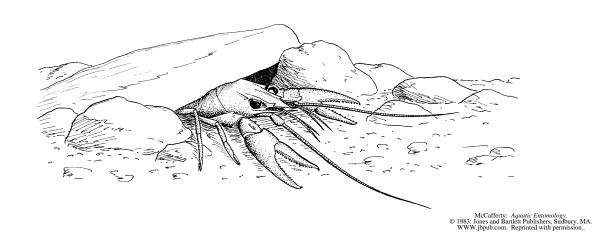
- Identify two potential cause and effect relationships involving aquatic pollution.
- List and evaluate two alternative solutions to aquatic pollution.
- Create an action plan to reduce pollution and improve the sustainability of a river, stream, pond or other water body.

Correlation Chart

Note to classroom teachers: The following Correlation Chart shows how each activity in this Environmental Education Learning Experience (EELE) correlates with the North Carolina Department of Public Instruction (DPI) objectives in science, mathematics, social studies and English language arts. The activities are listed in the order in which they appear in this EELE. The recommended grade levels are listed along the side of the chart. Notice that only the objective numbers are listed. Use your DPI Teacher Handbook for each subject area to get a complete description of the objectives in that subject area.

Pre-Visit Activity *1: Map Trivia, p. 3.1.1

Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
6	1.03 Nature of Science Personal & Social Perspectives	1.3, 2.2, 3.2, 3.9		2.12
7	1.04 Nature of Science Personal & Social Perspectives	2.3, 3.2		
8	1.04,1.05, 2.01 Nature of Science Personal & Social Perspectives	1.1, 2.1, 3.2, 3.6, 3.7	1.1, 1.2, 1.3 Skill Goals I & II	2.2
Earth Science	4.06, 7.02 Nature of Science Personal & Social Perspectives			



Cor	Correlation Chart					
Pre-Vis	sit Activity #2: The l	Key to Water Quality,	p. 3.2.1			
Grade	Science	English Lang. Arts	Soc. Studies	Mathematics		
6	2.03, 2.04 Personal & Social Perspectives	1.1, 2.1, 2.3, 3.2, 3.9				
7		2.2, 2.3, 3.2				
8	1.04, 2.03 Personal & Social Perspectives	1.1, 1.3, 2.1,3.2				
Biology	3.02, 4.01, 4.03, 5.01 Personal & Social Perspectives					

On-Site	On-Site Activity #1: Go with the Flow, p. 4.1.1				
Grade	Science	English Lang. Arts	Soc. Studies	Mathematics	
6	2.03, 2.04 Science as Inquiry Personal & Social Perspectives	1.3, 2.1, 2.3, 3.2, 3.9		1.13, 2.10, 2.11, 2.13	
7		2.3, 3.2, 3.11		1.8, 2.9, 3.3	
8	1.02, 1.04, 2.02, 2.03, 2.05, 4.06, 4.07 Science as Inquiry Personal & Social Perspectives	2.1, 3.2, 3.6, 3.7, 3.10	1.3, 11.2 Skill Goals I & II	1.12, 2.1, 2.12, 3.1	
Earth Science	1.05, 4.01, 4.06, 7.01, 7.02 Science as Inquiry Personal & Social Perspectives				

Cor	Correlation Chart				
On-Site	Activity #2: Mind	Your p's and H's, p. 4	1.2.1		
Grade	Science	English Lang. Arts	Soc. Studies	Mathematics	
6	2.03 Science Inquiry Personal & Social Perspectives	1.3, 2.2, 2.3, 3.2, 3.9			
7	1.04, 4.05 Science Inquiry Personal & Social Perspectives	1.2, 1.3, 2.3 3.2			
8	1.02, 1.04, 2.03 Science Inquiry Personal & Social Perspectives	2.1, 2.6, 3.2, 3.6, 3.7, 3.10			
Earth Science	4.06, 7.02 Science Inquiry Personal & Social Perspectives				

On-site	On-site Activity *3: Sediment: The "S" Word, p. 4.3.1			
Grade	Science	English Lang. Arts	Soc. Studies	Mathematics
6	1,03, 2.03 Science Inquiry Personal & Social Perspectives	1.3, 2.2, 2.3, 3.2, 3.9		
7		1.2, 1.3, 2.3, 3.2		
8	1.02, 1.04, 1.05, 2.03, 2.05 Science Inquiry Personal & Social Perspectives	2.1, 2.6, 3.2, 3.6, 3.7, 3.10		
Earth Science	1.04, 4.01, 4.06, 7.02 Science Inquiry Personal & Social Perspectives			

Correlation Chart

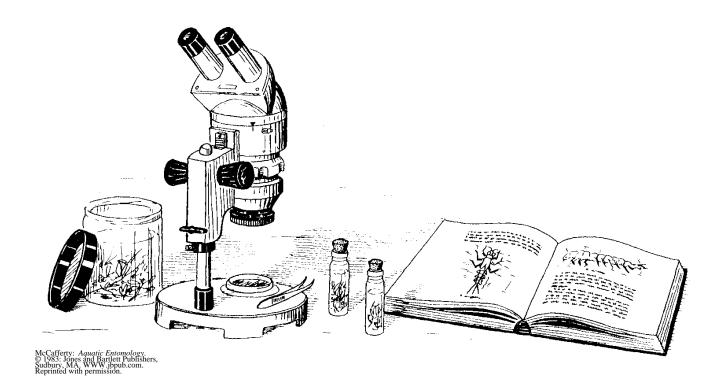
On-site	On-site Activity #4: Water Bugs, p. 4.4.1				
Grade	Science	English Lang. Arts	Soc. Studies	Mathematics	
6	2.03, 2.04 Science Inquiry Personal & Social Perspectives	1.2, 1.3, 2.1, 2.3, 3.2, 3.9		1.9, 1.13, 3.4, 4.1, 4.2	
7		1.2, 2.3, 3.2		3.3, 3.5, 4.4	
8	1.02, 1.04, 2.02, 2.03 Science Inquiry Personal & Social Perspectives	1.1, 1.3, 2.1, 3.2, 3.6, 3.7, 3.9, 3.10		1.2, 1.12, 3.1, 4.4, 4.6	
Biology	3.02, 3.03, 4.01, 4.02, 4.03, 5.01 Science Inquiry Personal & Social Perspectives				

Post-Vi	Post-Visit Activity #1: Fragile Waters, p. 5.1.1				
Grade	Science	English Lang. Arts	Soc. Studies	Mathematics	
6	1.03, 2.02, 2.03 Sci. & Technology Personal & Social Perspectives	1.2, 1.3, 2.2, 3.2, 3.4, 3.9			
7	1.04 Sci. & Technology Personal & Social Perspectives	1.2, 1.3, 2.3, 3.2, 3.3, 3.11, 3.12			
8	1.04, 1.05, 2.03, 2.05 Sci. & Technology Personal & Social Perspectives	1.1, 1.2, 2.3, 2.6, 3.2, 3.3, 3.7, 3.9, 3.10	1.1, 1.2, 1.3, 1.4, 1.5, 3.2, 11.2 Skill Goals I, II, III, & IV		
	4.06, 7.02, 7.03 Sci. & Technology Personal & Social Perspectives				

Correlation Chart

Post-Visit Activity *2: Troubled Waters, p. 5.2.1.

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Grade	Science	English Lang. Arts	Soc. Studies	Mathematics	
6	1.03 Nature of Science Personal & Social Perspectives	1.3, 1.5, 2.2, 3.1, 3.2, 3.4, 3.9, 3.12, 4.1, 5.1, 5.4, 5.7, 6.2			
7	1.04 Nature of Science Personal & Social Perspectives	1.1, 1.2, 1.3, 2.3, 3.1, 3.2, 3.11, 3.12, 4.1, 4.2, 5.3, 5.6, 6.2, 6.7			
8	1.04,1.05, 2.01, 2.02, 2.03, 2.05 Nature of Science Personal & Social Perspectives	1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 3.2, 3.6, 3.7, 3.9, 3.10, 4.1, 4.2, 4.3, 5.1, 5.5, 6.2, 6.3	1.3, 11.2 Skill Goals I-IV		
Earth Science	4.06, 7.02, 7.03 Nature of Science Personal & Social Perspectives				



Major Concepts:

- River basin
- Watersheds
- Point and nonpoint source pollution

Learning Skills:

- Observing, communicating, inferring
- Reading and interpreting maps
- Estimating distances

Subject Areas:

- Science
- English Language Arts
- Social Studies
- Mathematics
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location: Classroom

Group Size: 30 students

Estimated Time: 60 minutes

Appropriate Season: Any

Materials:

Provided by educator:
Per student: One copy of
Student's Information and
Neuse River Basin Map
Per group of 4 students:
Map Trivia worksheet and
current North Carolina
transportation map

Maps are available through your local tourism office or by calling:

1-800-VISITNC or 1-877-DOT-4YOU

Objectives:

• Interpret and use the legends on the North Carolina transportation map to answer five questions.

 Locate five geographic locations within the Neuse River Basin.

• Identify potential sources of point and nonpoint pollution in the Neuse River Basin.

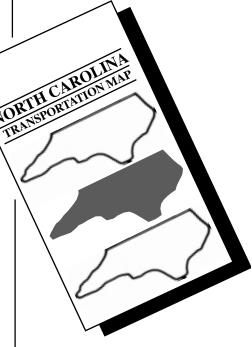
Educator's Information:

This activity is designed to illustrate the concept that the Eno River watershed is part of a larger river system—the Neuse River Basin. Students will trace the river from its headwaters to the ocean, using map legends and identifying key geographic locations along the water course. Students will participate in a group activity to obtain the answers for the worksheet.

Instructions: Part 1 – Map Trivia

1. Provide one North Carolina transportation map and one worksheet for every four students.

Note: The 2000 transportation map includes an insert



on river basins. This map is preferred for this activity.

- **2.** Have each group of students answer questions on the worksheet, using the map as a reference.
- 3. After the groups have finished their worksheets, have each group answer one of the questions and explain how they got the answer to the class. Continue with each group reporting their answer until all questions have been answered and discussed.

Part 2– Sources of Water Pollution

1. Have students use the Neuse River Basin map in this activity, along with the DOT map, to determine how many cities with a population over 10,000 exist in the Neuse River Basin. [Answer: eight—Durham, Cary, Raleigh, Garner, Smithfield, Goldsboro, Kinston, and New Bern.]

Ask students to find the population growth statistics located on the Neuse River Basin map. Note also that one-third (33%) of all the monitored streams in the basin are listed as "impaired" (from the 1998 study of the Neuse). Discuss: If population continues to grow as projected, what might happen to the water quality in the river basin? Explain. Sample Answer: The water quality of the basin would likely decrease due to increased amounts of sedi**ment** and other types of runoff from lawns, streets and parking lots. To provide for a growing population, more water will be needed for households. businesses and industries. A reduction in the quantity of water would result in a concentration of pollutants in the remaining water supply.

2. Ask students to read the Student's Information that discusses point and nonpoint source pollution. Then, using the Neuse River Basin map and the DOT map, teams of students should list possible sources of point and nonpoint pollution in the Neuse River Basin. (To find out about actual sources of pollution, call the Divison of Water Quality at (919) 733-5083 to receive a copy of the Neuse River Basinwide Water Ouality Management Plan. Or, see web site given under Extensions.)

Assessment:

As a post-test, design some questions of your own about the Neuse River Basin (or another river basin), based on the DOT map. In addition, ask students to write their answers to the following questions:

- Define point and nonpoint source pollution, giving examples of each.
- Explain the connection between air and water pollution.
- Describe at least three ways that they, as individuals, may be contributing to water pollution and what can be done about it.

Extentions:

If research on the web is possible, have students find out what river basin they live in. Use the Division of Water Quality web site at: http://h2o.enr.state.nc.us/wqs/ At this site, you can view basin statistics and maps for all the river basins in North Carolina. You can also find recent data on dissolved oxygen, salinity, pH, etc. for the Neuse River.



Each of us lives in a water-shed. Unfortunately, many of our watersheds today are being damaged by pollution. Water pollution is generally defined as human-caused contamination of water that reduces its usefulness to humans and other organisms.

Scientists divide water pollution into two major categories: point and nonpoint. **Point source pollution** comes from a localized source and is fairly easy to pinpoint. An example would be a specific type of chemical that a factory releases through a pipe into a stream. The factory may be the only source of this particular chemical in the watershed. We could prevent further pollution from the chemical by ordering the factory to stop discharging into the water.

Nonpoint source pollution

cannot be easily traced to a specific source. It often occurs as **runoff** from large areas such as farms, logging roads, construction sites, lawns, streets and parking lots. Nonpoint source pollution does not enter the waterway at a single point or orginate from a single location. Therefore, it is much harder to manage than point source pollution. Examples of nonpoint source pollution include **sediment**, nutrients and pesticides.

Sedimentation

Sediment is the main source of pollution of North Carolina's surface waters. Sedimentation (or **erosion**) results mainly from construction sites, urban runoff, row-cropping, livestock operations, and logging operations. Sediment often carries other pollutants along with it. It can have a negative impact on recreational, industrial and municpal water uses, as well as on aquatic habitats. Sediment can fill lakes, navigation channels and harbors, resulting in costly dredging operations.

Nutrients

Other than sediment, the pollutants of greatest concern from both rural and urban areas are nutrients. Nutrients are compounds containing nitrogen and/or phosphorous. They stimulate plant growth, causing algal blooms. When the algae die and sink to the bottom, they use up oxygen as they decompose. Fish kills occur when dissolved oxygen drops below levels needed by fish to breathe.

Point sources of nutrients may be traced to septic tank failures or discharges from wastewater treatment plants. Nonpoint sources include runoff from urban lawns and farm fields, as well as atmospheric sources.

Air Pollution

Atmospheric pollutants can cause problems when they reach water bodies as wet or dry fallout. According to recent scientific studies, 25-50% of the nitrogen entering eastern North Carolina waterways each year comes from atmospheric sources. One important source is the combustion of fossil fuels in vehicles, factories and power plants. Another source is the vaporization of wastes and fertilizers from large farming operations and wastewater treatment plants. Nitrogen oxides contribute to acid rain, which increases the acidity of our waters.

It is important to realize that the Eno River watershed is connected to many other small watersheds that make up the Neuse **River Basin**. If one watershed in the basin becomes contaminated, it will eventually affect all the watersheds downstream. Watersheds near the ocean can be severely degraded by the accumulation of pollutants from many sources.

As you explore the Neuse River Basin on the transportation map, consider the various sources of pollution that might enter the basin from Hillsborough to the Atlantic Ocean.

Neuse River Basin Map

Major cities and towns are dark gray. Note: Lakes, rivers and sounds are shown in black. ORANGE PERSON **Neuse River Basin Statistics** GRANVILL Buffajo Cr. JOHNSTON LENOIR % Impaired Monitored in Basin: 33% **Impaired Monitored Stream Miles: 454** Pop. Density (1990):181 persons/square mile % pop. increase: 36% Projected Pop. (2017): 1,593,937 Est. Population (1996): 1,175,032 Population (1990): 1,015,511 No. of Subbasins: 14 than 5% of their area in basin) No. of Counties: 24 (17 counties with more Stream Miles: 3,440 Area: 6,235 square miles CRAVEN PH Map Courtesy of Department of Environment and

Natural Resources, Division of Water Quality

Map Trivia Worksheet

Instructions: Using the North Carolina transportation map, answer the following questions. **9.** What is the name of the **1.** What is the name of the **16.** New Bern is closest to county where the Eno River sound into which the water what latitude and longitude? from the Eno River flows? begins? **2.** Name the 5 counties **10.** Approximately how many **17.** Name at least six points miles are there between of interest (see map symbols) surrounding Orange County. Durham and New Bern in a within 3 miles of the Eno and Neuse Rivers from Eno River straight line? State Park to New Bern. kilometers ?___ **3.** Name the river that joins the Eno River near Camp **11.** List at least 3 state parks Butner (northwestern end of and recreation areas located Falls Lake)? along the path that the Eno River takes to the ocean. **4.** List the counties the Eno **18.** Name the national forest River flows through before befound along the Neuse River. coming the Neuse River near Camp Butner (northwestern end of Falls Lake). **19.** Name the river located **12.** What is the approximate west and south of the Eno distance from Ranger, NC to River near Burlington. Whalebone, NC?

- **5.** Approximately how long is the Eno River? in miles ______ in kilometers
- **6.** What is the name of the reservoir into which the Eno River flows?
- **7.** What is the name of the river which eventually carries the water from the Eno to the ocean?
- **8.** What is the first town with a population over 2,000 through which the Eno flows?
- **14.** A major tributary that drains parts of Greene, Pitt and Wilson counties enters the Neuse River just below what city (with a population over 10,000)?

in miles _____

13. What is the map symbol

for park campsites?

in kilometers

15. What is the closest **latitude** and **longitude** to Eno River State Park?

20. Near what large city does the river from question 19 reach the ocean?

To what river basin does it

belong?

- **21.** Name the river (or river basin) located north and east of Falls Lake.
- **22.** Near what city (with population over 10,000) does the river from question 21 mix with the waters of the Pamlico Sound?

Answers for Map Trivia

- 1. Orange County
- 2. Caswell, Person, Durham, Alamance, Chatham
- 3. Flat River
- 4. Two Orange and Durham
- 5. Approximately 33 milesApproximately 53 kilometers
- 6. Falls Lake
- 7. Neuse River
- 8. Hillsborough
- 9. Pamlico Sound
- 10. Approximately 120 milesApproximately 193 kilometers

- 11. Eno River State Park, Falls Lake State Recreation Area, Waynesborough State Park (on 92/93 or later maps), Cliffs of the Neuse State Park
- 12. Approximately 500 miles
 Approximately 805 kilometers
- 13. A tent
- 14. Kinston
 Note: The tributary, not named on the DOT map, is Contentnea
 Creek.
- 15. 79 degrees longitude, 36 degrees latitude
- 16. 77 degrees longitude,35 degrees latitude

- 17. Bennett Place, Stagville Center, Clemmons Educational State Forest, Waynesborough State Park (on 92/93 or later maps), Cliffs of the Neuse State Park, Caswell Memorial & CSS Neuse, Tryon Palace, Ava Gardner Museum
- 18. Croatan National Forest
- 19. Haw River; Cape Fear River Basin
- 20. Wilmington, NC
- 21. Tar River (or Tar-Pamlico River Basin)
- 22. Washington, NC

Pre-Visit Activity #2

The Key to Water Quality

Major Concepts:

- Dichotomous key
- Indicator species
- Water quality
- · Aquatic food webs

Learning Skills:

- Observing, classifying, and communicating
- Reading taxonomic keys

Subject Areas:

- Science
- English Language Arts
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location: Classroom

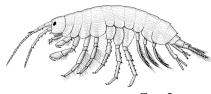
Group Size: 30 students

Estimated Time: 50 minutes

Appropriate Season: any

Materials:

Provided by educator:
Per student or group: One
copy of the following—
Student's Information; Key
to 10 Common Leaves; 10
Common Leaves; Key to
Common Macroinvertebrates
Found at Fews Ford, Eno
River State Park; and Aquatic Life Illustrations.



Sci
Cafferty: Aquatic Entomology.
983:Jones and Bartlett Publishers, Sudbury, MA.

Objectives:

- Use simple dichotomous keys to identify pictures of ten unknown leaves and five unknown macroinvertebrates.
- Name at least two aquatic macroinvertebrates that are tolerant of pollution and two that are intolerant of pollution.
- Give at least two reasons why macroinvertebrates are important to humans.

Educator's Information:

This activity introduces students to dichotomous keys. Students will key out several macroinvertebrates, using the same key that they will use at the park during On-Site Activity #4, "Water Bugs." Students will also learn that macroinvertebrates are indicator species that help us determine water quality. A discussion of their role in aquatic food webs is included in the Student's Information.

Instructions:

Have the students read the Student's Information and use the Key to 10 Common Leaves to identify the leaves on the 10 Common Leaves worksheet. As a class, go over the answers and discuss any difficulties encountered. Next, give each student (or group) a copy of Aquatic Life

Illustrations and the Key to Common Macroinverte-brates. As a class, work through the key to identify animal #1, then have the students identify the rest of the macroinvertebrates on their own.

When everyone is done, have individual students or groups share how they identified one of the macroinvertebrates. Ask them to use the Key to Common Macroinvertebrates to determine if their organism is tolerant, intolerant or moderately tolerant of pollution. Discuss the importance of macroinvertebrates as indicators of water quality and members of food webs.

Assessment:

Use the test found at the end of this activity. Can students follow the "text only" key to identify the five unknown macroinvertebrates? On the back of their papers, ask students to write, in paragraph form, two reasons why macroinvertebrates are important to humans.

Test Answers: 1-caddisfly larva, 2-scud, 3-mayfly nymph, 4-ramshorn snail, and 5-riffle beetle adult. The scud is moderately tolerant of pollution. All the others are intolerant.

Student's Information: The Key toWater Quality

Name That "Bug"!

One important method for determining water quality is to look at what lives in the water. When you visit Eno River State Park, you'll be doing just that—identifying water "bugs"!

The numbers of organisms you find in the river and the diversity of **species** will tell you if the river is healthy. Excellent water quality is indicated by the presence of a large number of different kinds of organisms, especially those intolerant of pollution. Examples of animals that require excellent water quality are stoneflies, freshwater mussels and water pennies. Only certain kinds of animals are able to live in polluted water. If the acidity of the water is too high or if dissolved oxygen is too low, most aquatic animals cannot survive. Examples of animals that are tolerant of pollution are black fly larvae, leeches and certain types of worms.

In this activity, you'll meet some of the animals that live in the Eno River. You'll also learn how to identify or classify them using a **dichotomous key**. A dichotomous key divides characteristics that describe organisms into two choices. At each level of the key, you will pick the choice that best describes the organism you are trying to identify.

How a Dichotomous Key Works

Practice using the Key to 10 Common Leaves first. Notice that the list of leaf characteristics is arranged as a series of either/or statements. For each pair of statements, only one will be the correct description of the unknown leaf. For example, if you are handed a leaf from a pine tree to identify, you would start at the top of the key with these two choices:

1. Leaf long and needle-like, or

2. Leaf not needle-like.

A pine needle is long and needle-like, so you would choose statement 2 and continue to the next pair of choices under that side of the dichotomous key.

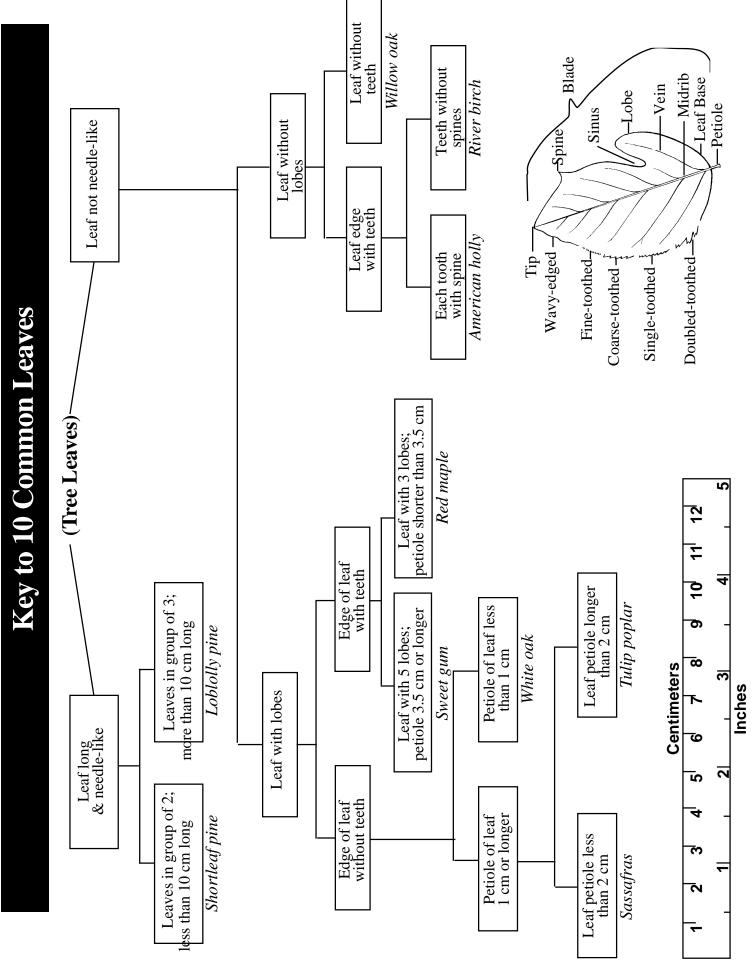
After you have mastered the leaf key, you can try the Key to Common Macroinvertebrates. A macroinvertebrate is an invertebrate (animal without a backbone) that can be seen with the naked eye. Many of them are **insects** or insect larvae, but only a few are true bugs. Macroinvertebrates also include many non-insect groups—mollusks (example: snails and mussels) and crustaceans (example: crayfish). Notice that each macroinvertebrate's name on the key is followed by a letter "T" (tolerant of pollution), "I" (Intolerant) or "M" (moderately tolerant).

Food Webs

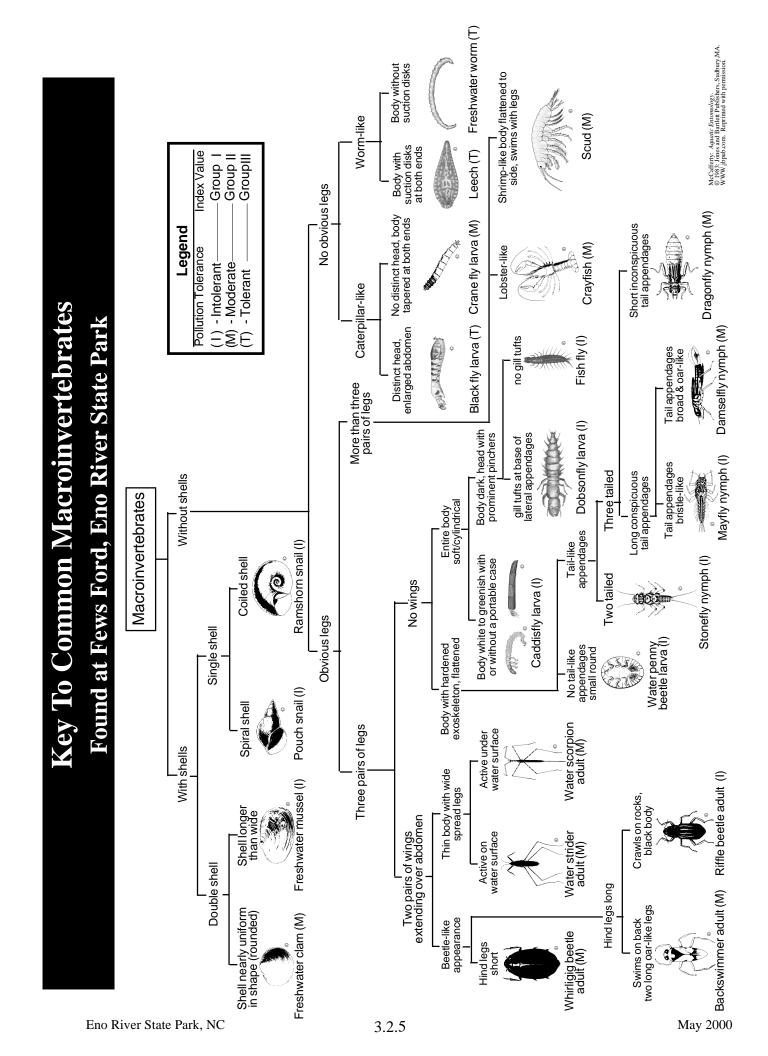
Many of the macroinvertebrates are predators that eat other animals; for example, the dobsonfly larva and the dragonfly nvmph. Others, like freshwater mussels, scuds and caddisfly larvae, eat detritus (decaying materials) in the water. Some, like leeches, are parasites on fish, reptiles or mammals. All the macroinvertebrates play an important role in the **food web** of a river or stream. For example, many fish depend on aquatic insects for food. Without them, most of the fish would starve and the food web would begin to collapse. Mussels, snails and crayfish are eaten by a wide variety of animals, including more terrestrial species such as the raccoon.



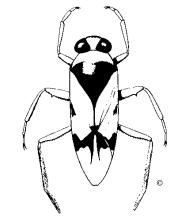
So the next time you see an "ugly bug" in the water, don't turn away in disgust. Learn its name by keying it out! This little animal can tell you what's happening to your favorite swimming hole or to the water supply for your town. That's why we call it an **indicator species**—its presence or absence can be used to determine the health of a particular environment. Remember that "beauty is in the eye of the beholder"!

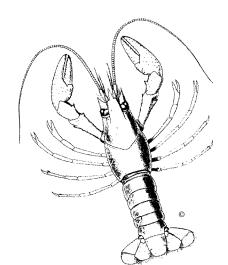


10 Common Leaves <u>5.</u>

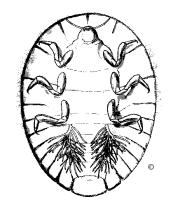


Aquatic Life Illustrations

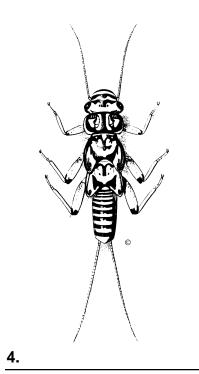




1.

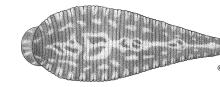


2.



3.

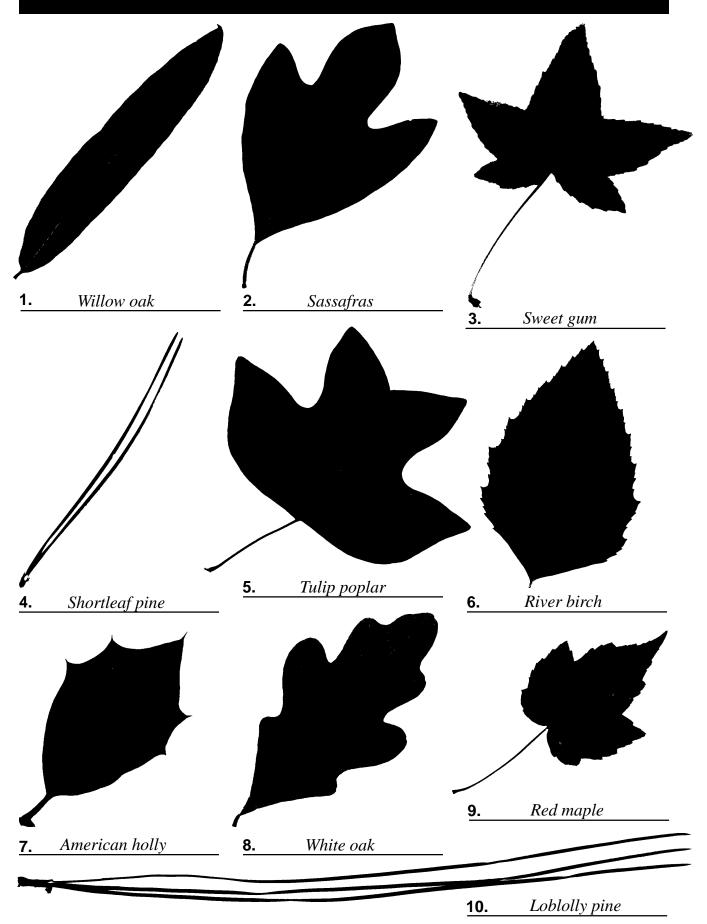




6.

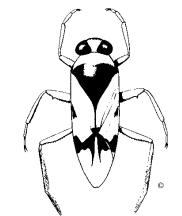
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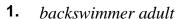
Answer Sheet to 10 Common Leaves

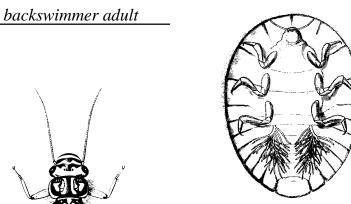


Eno River State Park, NC 3.2.7 May 2000

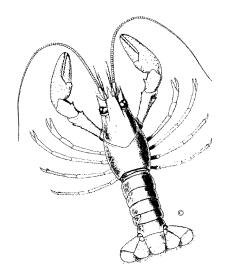
Answer Sheet to Aquatic Life Illustrations



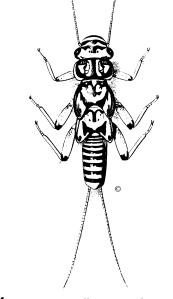




water penny



crayfish 2.



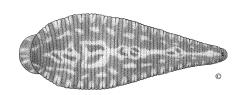
stonefly nymph



freshwater mussel

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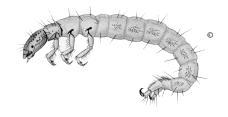


6. leech

The Key to Water Quality – Test

Can you identify these five macroinvertebrates? Use the key to help you.

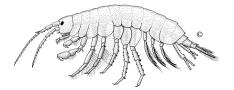
1.



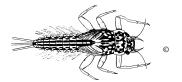
with case



2



3.



sideview



4.



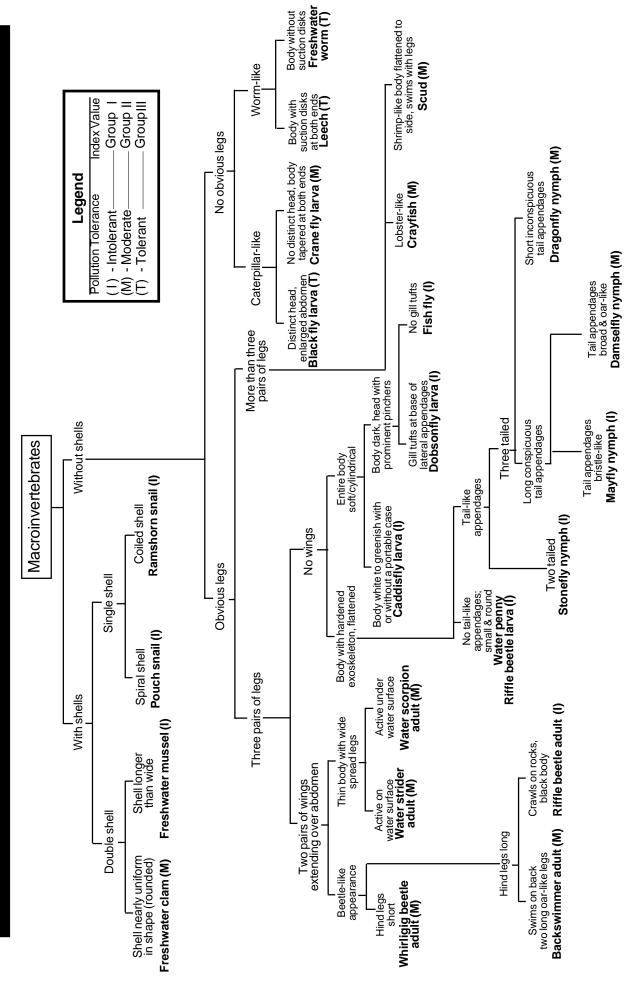
5.



Note: This winged insect was found crawling on rocks in the river.

6. Which of the five animals (above) could live in water that is somewhat polluted?

The Key to Water Ouality - Key for Test



On-Site Activity #1

Go With The Flow

Major Concepts:

- · Water flow
- Water quality
- Natural and human influences on water flow
- Aquatic habitats

Learning Skills:

- Observing, using numbers, collecting data in the field
- Measuring, averaging numbers, calculating water flow

Subject Areas:

- Science
- Mathematics
- English Language Arts
- Social Studies
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location:

Fews Ford Access Area

Group Size:

8 students per group

Estimated Time: 30 minutes

Appropriate Season:

April through October

Materials:

Provided by park:

life jackets, throw ropes, 100 ft. tape measure, metal yardstick, stopwatches, tennis balls, boundary ropes, charts, activity sheets, clipboards, pencils Provided by educator: worksheets (one per stu-

Special Considerations:

dent), pencils

See the safety message in the Introduction page 1.3.

Calculating Water Flow in the Eno River

Objectives:

- Calculate the rate of water flow using measurements and a mathematical formula.
- List three human actions that affect water flow.
- List three natural influences on water flow.
- Describe the important relationship between water quantity and quality.
- Describe three problems that can result from river water quantity extremes.
- Describe three problems that can result from river water quality changes.
- Discuss at least two things people can do to help protect rivers and water quality.

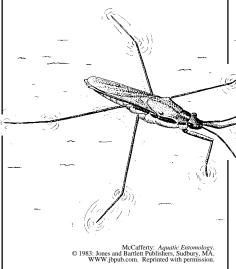
Educator's Information:

In this activity, the students will learn a simple method for determining water flow. They will then use this information to explore the ways that water flow and water quality are affected by human and natural factors. They will also be asked to think of ways they can influence local governments to protect water quality.

To prepare your students for their visit we recommend Pre-visit Activity #1, "Map Trivia."

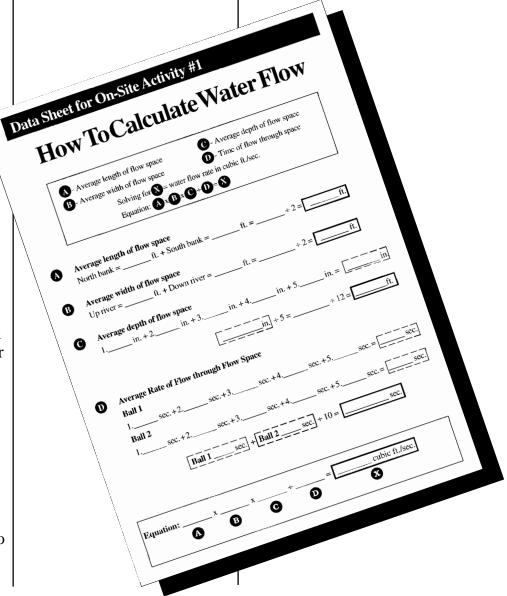
Instructions:

- 1. Prior to your visit to the park, have students read the Student's Information. Lead a brief discussion concerning the importance of water flow in maintaining water quality. Explain that in this activity, the students will learn how to calculate water flow and thus
 - be able to evaluate this aspect of the Eno River's water quality.
- 2. Explain the method for measuring water flow and safety procedures that must be followed.
- 3. Select three students to get into the water. Have two students measure the length and width, and one student



- measure the depth of the flow space. Have the other students write down the measurements on their worksheets.
- 4. Select four students to measure the rate of flow. Have two students, each with a ball, go to the upstream end of the flow space. Have two other students, each with a stopwatch, go to the downstream end of the flow space. The student with ball #1 should place it in the river upstream from the beginning of the flow space and hold his/her hand in the air. As the ball passes the beginning of the flow space, he/she quickly drops his/her hand. This is the signal for the student with stopwatch *1 to start the stopwatch. The stopwatch is stopped the moment the ball passes out of the flow space. He or she will then retrieve the ball, and they will repeat this four more times. The students with ball #2 and stopwatch #2 will follow the same procedure. The other students will record the flow rates on their worksheets as the students with the stopwatches announce them.
- 5. Have all the students determine the four averages and then calculate the water flow rate in cubic feet/second. Discuss these results and what they might mean to the Eno River's water quality.

- **6.** Lead a discussion of factors that affect water flow (natural and human), and how these factors in turn affect **aquatic life**. (Natural factors affecting water flow include drought, flooding and natural stream obstruction, i.e., beaver dams or log jams. Human activities include dams, irrigation, and industrial use. These natural and unnatural water controls can adversely impact aquatic organisms by reducing water flow and decreasing water quality. See "Water Flow
- Basics" under Student's Information for specific examples of how changes in water flow alter aquatic habitats.)
- 7. Discuss how low (or high) water flow can affect aquatic **food webs**. (When the aquatic habitat changes as a result of water flow decrease or increase, some animals may die. Other animals that depend on them for food will also eventually die.)



8. Ask the students how they can influence the government to protect our water resources. Be sure to emphasize the importance of everyone being involved in caring for our resources (stewardship). The Eno River Association is an organization that exemplifies stewardship. If time allows, the leader will briefly explain how the park was created with the help of the Eno River Association.

Assessment:

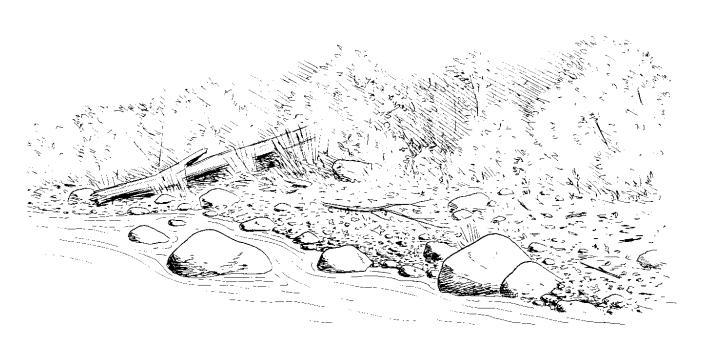
Pencil and Paper Test—

- 1. Create your own post-test by filling in the sections A, B, C, and D on the work-sheet in this activity. Can students calculate the water flow with the data you have provided?
- **2.** Ask students to list three natural causes and three human causes for changes in water flow.
- **3.** Have students describe two ways that low flow can affect water quality. Repeat for high flow.

4. Finally, ask your students to give several ways that people can protect rivers and water quality.

Extension:

Although water flow is more often expressed in cubic feet per second, you can ask your students to convert this to the metric system. To convert cubic feet per second to cubic meters per second, multiply by 0.03. Example: 371 cubic feet per second becomes 11.13 cubic meters per second.



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Water flow refers to the amount of water moving in a river or stream. Some of the ways that we express the rate of flow are gallons per second, cubic feet per second, or acre feet per second. (An acre foot is equal to one acre of water one foot deep, or 325,850 gallons of water.) When you visit Eno River State Park, you will participate in an activity to estimate the water flow in cubic feet per second. Why is this important? Read the following story and discover why water flow is such an important concept.

The river is the Colorado. It begins in the Colorado Rockies and empties 1,450 miles later into Mexico's Gulf of California. The Colorado provides water for seven western states. This includes water for human consumption as well as irrigation for farms and domestic livestock. The Colorado is one of the most controlled rivers in the world. It has scores of dams, hundreds of miles of aqueducts and tunnels, dozens of pumping stations, thousands of miles of canals, and more than 30 hydroelectric plants. Water is pumped from the Colorado to cities like San Diego, California; Las Vegas, Nevada; Denver, Colorado; and Phoenix, Arizona. Each year 16.5 million acre feet of water are diverted from the Colorado! (Multiply 16.5 million by 325,850 to see how many gallons are taken from the river each year—over five trillion gallons!) Sometimes the water level is so low that rafters can not run certain rapids in the Grand Canyon.

Dams above the canyon control how much water moves through the canyon. This has had a big impact on aquatic life. For example, before the Colorado was dammed, the river flowed cold and carried lots of mud and silt during the spring floods. In the fall, it slowed to a warm clear trickle. Native **species** were well adapted to these conditions. Now dams trap **sedi**ment in huge reservoirs and constantly release clear cold water from the bottom of the lake. This creates excellent **habitat** for introduced species, like trout, but is contributing to the near extinction of several native species of fish that do not tolerate the cold water.

By the time the Colorado River reaches the Gulf of California, it is barely a trickle. At times the river dries up before it reaches the gulf. Even if there is water flowing, **evaporation** has caused it to become very salty. At this point, the salt content averages 700 parts per million, which is much too salty for irrigation.

A huge delta and estuary at the mouth of the Colorado used to be one of the most productive in the Southwest. However, the decrease in water flow has caused many changes. In 1922 ecologist Aldo Leopold explored the delta. He described it "as a milk and honey wilderness where egrets gathered like a premature snow storm, jaguars roamed, and wild melons grew." Since that time two marine animals have become endangered—one a porpoise and one a large fish called a totoaba. (The totoaba spawned in the estuary, and the tide carried their eggs up into the natural nursery of the delta.)

According to saltwater agronomist Nicholas Yensen, "The river was like the Nile in its importance to the delta; unknown species may have disappeared..." As a result of the decrease in water flow, entire aquatic **communities** have disappeared and **food webs** have collapsed.

Water Flow Basics

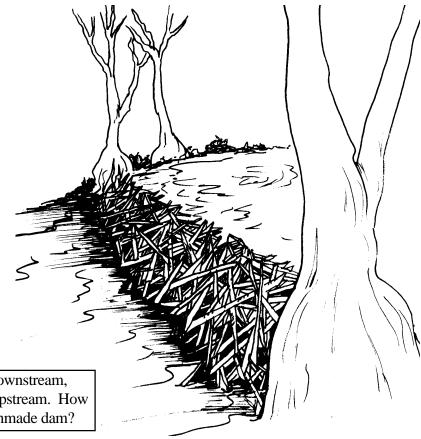
You might be surprised to learn that even the Eno is affected by low water flow. Such conditions can have adverse effects on the entire aquatic community.

- When water levels are low, the water temperature can increase and result in less **dissolved** oxygen being available. This can be deadly to macroinvertebrates and fish.
- Algae can spread rapidly during low water flow, and these plants use tremendous amounts of oxygen as they decay. Fish kills can occur because of insufficient dissolved oxygen.
- During low water levels there is less habitat for river animals, and they become more vulnerable to predators.

- Low water flow also means low water volume.
 With less water available to dilute pollutants, toxic levels are reached more quickly.
- Last but not least, you might be forced to conserve water during low flow periods to make sure you have enough to drink and bathe.

W e have talked a lot about low water levels but high flow levels affect us also. Heavy rains wash exposed soil into the river. This sediment can suffocate macroinvertebrates, kill fish eggs, and alter habitat. A lot of towns and cities divert rainwater into storm drains that empty into rivers. This stormwater can bring toxic materials into the river: vehicle oil and gas from pavement; chemicals used in farming and lawn care; overflow from wastewater treatment plants; and trash from dumps and other sources.

As you can see, water flow is very important to us. Using water wisely and protecting our river's **water-shed** from unwise use are two ways we can help maintain a healthy and more natural water flow.



A beaver dam reduces water flow downstream, while providing a **wetland** habitat upstream. How does a beaver dam differ from a manmade dam?

Worksheet for On-Site Activity #1

How To Calculate Water Flow

- A Average length of flow space
- **C** Average depth of flow space
- B Average width of flow space
- **D** Time of flow through space

Solving for \mathbf{X} = water flow rate in cubic ft./sec.

Equation: $\mathbf{A} \times \mathbf{B} \times \mathbf{C} \div \mathbf{D} = \mathbf{X}$

A Average length of flow space

North bank _____ ft. + South bank ____ ft. = ____ $\div 2 =$ ____ ft.

B Average width of flow space

Up river _____ ft. + Down river ____ ft. = $\div 2$ = - ft.

C Average depth of flow space

1. ____ in. + 2. ___ in. + 3. ___ in. + 4. ___ in. + 5. ___ in. = $\begin{bmatrix} ----- \\ ---- \end{bmatrix}$

D Average rate of flow through flow space

Ball 1

Ball 2

1. ____sec. + 2. ____sec. + 3. ____sec. + 4. ____sec. + 5. ___sec. = ____sec. ___

 $\begin{bmatrix} \mathbf{Ball 1} \\ \mathbf{Sec.} \end{bmatrix} + \begin{bmatrix} \mathbf{Ball 2} \\ \mathbf{Sec.} \end{bmatrix} \div 10 = \underbrace{\qquad \qquad} \mathbf{sec.}$

Equation: _____ ft. x _____ ft. ÷ _____ sec. = _____ cubic ft./sec.



B

C

D

X

How To Calculate Water Flow

A - Average length of flow space

C- Average depth of flow space

B - Average width of flow space

D - Time of flow through space

Solving for \mathbf{X} = water flow rate in cubic ft./sec.

Equation: $\mathbf{A} \times \mathbf{B} \times \mathbf{C} \div \mathbf{D} = \mathbf{X}$

A Average length of flow space

North bank 80 ft. + South bank 95 ft. = 175 $\div 2 = 87.5$ ft.

B Average width of flow space

Up river $\underline{}$ ft. + Down river $\underline{}$ ft. = $\underline{}$ ft. = $\underline{}$ ft.

C Average depth of flow space

1. 10 in. +2. 18 in. +3. 24 in. +4. 12 in. +5. 6 in. $=\begin{bmatrix} -70 & \text{in.} \\ --- & \text{in.} \end{bmatrix}$

 $\begin{bmatrix} -70 & \text{in.} \\ -5 & \text{in.} \end{bmatrix} \div 5 = 14 \text{ in.} \div 12 \text{ in.} = 1.17 \text{ ft.}$

D Average rate of flow through flow space

Ball 1

1. <u>20</u> sec. + 2. <u>22</u> sec. + 3. <u>18</u> sec. + 4. <u>23</u> sec. + 5. <u>21</u> sec. = $\begin{bmatrix} -104 & \text{sec.} \\ -104 & \text{sec.} \end{bmatrix}$

1. <u>21</u> sec. + 2. <u>26</u> sec. + 3. <u>24</u> sec. + 4. <u>21</u> sec. + 5. <u>22</u> sec. = <u>114</u> sec.

 $\begin{bmatrix} \textbf{Ball 1} & \underline{\textbf{104}} & \sec. \end{bmatrix} + \begin{bmatrix} \textbf{Ball 2} & \underline{\textbf{114}} & \sec. \end{bmatrix} \div 10 = \begin{bmatrix} \textbf{21.8} & \sec. \end{bmatrix}$

Equation: 87.5 ft. x 79 ft. x 1.17 ft. ÷ 21.8 sec. = 371 cubic ft./sec.

A

B

C

D

X

On-Site Activity #2

Mind Your p's and H's

Major Concepts:

- Water quality
- pH range (acid-neutral-base)
- Acid precipitation

Learning Skills:

- Observing, classifying
- Reading informational materials with complex vocabulary
- Expanding on information

Subject Areas:

- Science
- English Language Arts
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location:

Fews Ford Access Area

Group Size:

8 students per group

Estimated Time: 30 minutes

Appropriate Season:

April to October

Materials:

Provided by the educator: pencils, student worksheet (one copy per student) Provided by the park:

Test paper, LaMotte Test Kit, "pH Ranges That Support Aquatic Life" poster, "Sample pH Range" poster, sample items (distilled water, Eno River water, vinegar, lemon juice, Liquid-PlumbrTM, RolaidsTM, Coca-ColaTM, soap, Formula 409TM, baking soda)

Special considerations:

Chemical reagents are used in water quality testing. Because misuse of these chemicals can be hazardous, standard chemical protection procedures will be required. Goggles and rubber gloves will be provided for all students handling testing kits. These must be worn at all times during test procedures. The educator will assist in seeing that all safety precautions are followed.

Objectives:

- Demonstrate the use of litmus paper and the LaMotte test kit for determining pH.
- Find the pH of at least three common substances.
- List two natural influences that can affect the pH rating of a river.
- List two human influences that can affect the pH rating of a river.
- State the North Carolina Environmental Management Commission's pH range for aquatic macroinvertebrates (6.0-9.0).

The Power of Hydrogen

Educator's Information:

In this activity, students will test the **pH** of several household products, as well as river water. Park staff will lead a discussion focusing on the pH scale, what pH ranges aquatic life will tolerate, and natural and human influences that can change the pH of a river or stream. The students will use litmus paper to test the pH of several items and record their results on the "Sample pH Range" worksheet. They will also use a LaMotte test kit to test the pH of distilled water and Eno River water and record their results on the "Sample pH Range" worksheet. Park staff and students will discuss their results and compare them to the "pH Ranges That Support Aquatic Life" poster. They will note the extreme ranges of the samples and be able to determine which organisms might be able to live in water with those pH's.

Have the students read the Student's Information prior to the park visit.

Instructions:

- 1. Review the pH information provided in the Student's Information. Discuss what the term pH means and how it is measured. Be sure to use an example—if the river's pH changes from 6 to 5, this means the river is now 10 times more acidic; from 6 to 4 would mean it is 100 times more acidic.
- 2. Have two students test the pH of the Eno River water using the LaMotte Test Kit. Have one student read how it is done from the instructions with the test kit while the other student does the test. Have the students then test the pH of the distilled water and the pH of the rainwater using the LaMotte Test Kit.
- **3.** Discuss the results, reinforcing the Student's Information. The Eno River water should fall between 6.0-9.0 to meet the standards for fresh water set by the N.C. Environmental Management Commission. Generally, the pH falls between 6.5-7.5, the best range for **macroinvertebrates**.



- Review how aquatic life is affected by pH. Be sure to cover the concept of tolerance ranges for different organisms. Use an example such as the one on mayfly **nymphs**. Also, discuss the range of pH tolerance found on the "pH Ranges That Support Aquatic Life" poster.
- **4.** Discuss with the students that the rainwater, collected in a park rain gauge, will have a varying pH. (Results for the park have been from 5.4 to 6.5.) Review the **acid precipitation** section of the Student's Information. Emphasize that rain is naturally acidic, with a pH around 5.5. Rain is buffered by the soil, resulting in stream water with a pH between 6 and 8. Note that there are naturally acidic bodies of water, particularly in the eastern part of the state. Finally discuss what acid precipitation is, where it comes from, and how it changes the pH of the stream water.
- **5.** Discuss other ways the pH of streams is changed, reinforcing the Student's Information, particularly:
 - pH increases with increases in **effluent** from **sewage** treatment plants (effluent is high in ammonia which neutralizes **acids**)
 - pH increases with **photosynthesis** in plants

- (photosynthesis removes carbon dioxide, CO₂)
- pH increases with **aeration** by **riffles** and rapids (aeration adds oxygen, O₂)
- pH decreases with an increase in rainfall (rainwater is typically more acidic)
- pH decreases with **decomposition** of plants (decomposition removes O₂)
- pH decreases with **respiration** (animal breathing releases CO₂)
- 6. Discuss the pH of household products (the pH of many products used for cleaning is basic, while the pH of items that taste sour is acidic). Explain the test procedure using litmus paper. Note that litmus paper can test a broad range of pH and that each litmus paper type covers a specific range within the pH scale.
- 7. Have one student come forward and pick a product to test. Prior to testing, have the student decide if the product will be basic, acidic or neutral. Have the student select a strip of litmus paper from within the range they think appropriate and place it in the product. Match the color on the litmus paper chart. Discuss the results and have the

student mark the class poster. All students should mark their own worksheet.

8. Continue this process until all products are tested.

To test RolaidsTM, soap and baking soda, dissolve the products with an equal amount of distilled water. Remind the students that pure, deionized water contains equal numbers of H⁺ and OH- ions and is considered neutral, pH of 7. Note that this will slightly buffer the true pH of these products, but the products will still provide examples of basic pH's. Point out that RolaidsTM and baking soda are both basic (pH of 9) and that baking soda could be used for acid indigestion just as well as RolaidsTM. Discuss some of the foods that give us acid indigestion. [Pizza (tomatoes), chili (tomatoes), orange juice (citric acid), etc.] We, too, are living organisms and can not tolerate drastic changes in pH! To test "you," have a student place the tip of a strip of paper on his or her tongue. Have the class decide if the student is acidic, basic, or neutral prior to the test.

9. Sum up the activity by emphasizing that aquatic life is affected when the pH varies a great deal from neutral.

A change in the pH of a river can be one of the first indicators of water quality problems and can quickly affect the aquatic life in the stream. Volunteers and park rangers test the Eno River several times each month for pH, dissolved oxygen, temperature, water flow and macroinvertebrate population and diversity. Several years ago, this vigilant testing of the river identified a chemical spill that put the pH over 12 for a period of time! Dedicated volunteers have also provided data to help establish water flow regulations controlling the amount of water that can be removed from the river. The Eno River is fortunate to have so many good stewards!

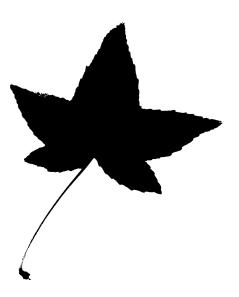
Assessment:

If you have litmus paper, or other method of testing for pH in your classroom, set up lab stations and ask students to find the pH of a variety of substances. Then, discuss, or ask students to write their answers to the following questions:

- **1.** Describe two events, one natural and one human-caused, that will <u>increase</u> the pH of a stream or river. Explain why.
- **2.** Describe two events, one natural and one human-caused, that will <u>decrease</u> the pH of a stream or river. Explain why.
- **3.** Give the Environmental Management Commission's acceptable pH range for North Carolina fresh waters.

Modification:

If time permits, take a short hike upriver and test the pH of the Eno at different sites along the trail. Ask the park staff for trail suggestions.



The term **pH** means (p)ower of (H)ydrogen ion activity. Scientists use the **pH** scale to define the degrees of acidity/basicity in soil and water. On one end of the scale, a pH of 0 is extremely acidic (many hydrogen ions, H⁺), whereas at the other end of the scale, a pH of 14 is extremely basic (many hydroxide ions, OH⁻). A pH of 7 is neutral (equal numbers of H⁺ and OH⁻ ions), being neither acidic nor basic. pH is measured on a logarithmic scale with each number representing a factor of ten. Thus, a change in a river's pH from 6 to 5 means that the river is now 10 times more acidic: from 6 to 4 means it is 100 times more acidic.

North Carolina has established water quality standards. For all fresh waters, except swamps, the acceptable pH range is 6.0 - 9.0 (swamps can have a pH as low as 4.3).

Aquatic life is affected when the pH varies a great deal from neutral. Different organisms tolerate varying ranges of pH, and the population of aquatic organisms will change if the pH changes favor certain species. For example, mayfly nymphs do best when the pH is around 6.5, but they usually cannot survive if the pH drops below 5.0. Most

macroinvertebrates do best if the pH is between 6.5 and 7.5.

The pH of rainfall is naturally acidic, usually registering from 5 to 5.5. However, many soils are somewhat basic and "buffer" the rainwater by raising its pH, making it less acidic. As a result, despite the pH of non-polluted rain being around 5.5, the pH of most stream water is between 6 and 8. However, you can find naturally acidic water in swamps, bogs, Carolina bays, and blackwater rivers in the eastern part of the state. There, the soils contain large amounts of peat (partially decayed plant material) which is acidic.

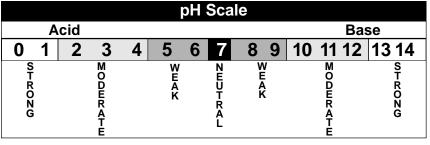
Some acidic waters are not natural, but the result of **acid precipitation**. Acid precipitation falls in the form of rain, snow, fog, sleet and hail. The acidity results primarily from the mixing of water vapor with sulfur dioxide (from coal burning power plants) and nitrous oxides (from cars and trucks) in the atmosphere. Acid precipitation can cause changes in the pH of our waterways.

The pH of water increases (becomes more **alkaline** or basic) with increases in the following: **effluents** from **sewage** treatment plants (the effluent is high in **ammonia**), **photosynthesis** in plants (photosynthesis removes carbon dioxide, CO₂), and **aeration** by **riffles** and rapids (aeration adds oxygen, O₂).

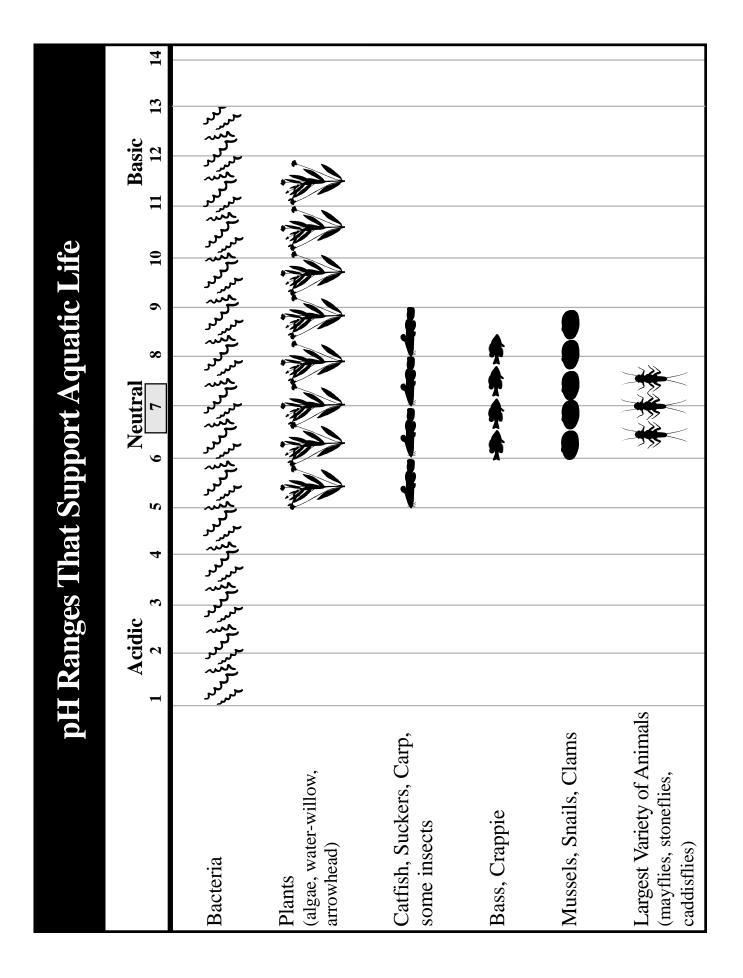
The pH of water decreases (becomes more acidic) with each of the following: increases in rainfall (allowing little or no buffering from the soil), **decomposition** of plants (decomposition removes O₂) and **respiration** (animal breathing releases CO₂).

Changes in pH can give valuable clues to water quality changes. A pH change, either an increase or decrease, may be an indication of biological processes such as decomposition of organic matter, photosynthetic activity or an increase/decrease in pollutant levels.

Monitoring the pH of our streams and rivers is of great importance. It can alert us to changes in our water quality and help us to protect our waters by giving us clues to the source of the changes.



Worksheet for On-Site Activity #2											
Sample pH Range											
	1	Ac 2	id 3	4	5	eut 7	9	10	11	ase 13	14
H ₂ O (Distilled)											
H ₂ O (Eno River)											
H ₂ O (Rain)											
Vinegar											
Lemon Juice											
Liquid-Plumbr™											
Yourself											
Rolaids™											
Coca-Cola™											
Baking Soda											
Formula 409™											
Soap											



On-Site Activity #3

Sediment: The "S" Word

Major Concepts:

- Water quality
- Sediment
- Sedimentation
- Water pollution

Learning Skills:

- Observing, inferring and predicting
- Reading technical information and expanding on ideas

Subject Areas:

- Science
- English Language Arts
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location:

Fews Ford Access Area

Group Size:

8 students per group

Estimated time: 20 minutes

Appropriate Season:

April to October

Materials:

Provided by the educator:
One copy of Student's Information per student
Provided by park:

Imhoff Cones (2), 2000 ml of water with high level of suspended solids

Objectives:

- Demonstrate how to measure sediment levels using the Imhoff cones.
- Describe three ways sediment affects aquatic life.
- List three origins of sediment and three possible ways to control the level of sediment in the river.
- List the most important causes of stream degradation in North Carolina today.

Educator's Information:

In this activity, students will observe and determine the amount of **sediment** in the test cones. They will discuss the origin of sediment, how sediment is tested in streams and lakes, and the effect of **sedimentation** and **turbidity** on **aquatic life**.

Instructions:

- **1.** Before coming to the park, discuss the Student's Information with your class.
- 2. Park staff will prepare a 1,000 ml sample of sediment-laden water in an Imhoff cone prior to the arrival of the students. When the students arrive the group leader will discuss sediment and turbidity. At this point,

the leader will pour another 1,000 ml of sediment-laden water into a second Imhoff cone.

- **3.** Have the students compare the two samples and observe that the second cone contains more suspended sediment; the larger particles are settling to the bottom, and the water near the surface of the cone is clearing. The first cone contains layers of sediment on the bottom; the water appears uniform in clarity from the surface to the first layer of sediment. Ask the students to explain why the water in the first cone is less turbid. (The water in the first cone is less turbid because it had time to settle and has not been disturbed – like a quiet pool.)
- **4.** Ask the students where sediment comes from, its effect on aquatic life, and ways to control sediment in a **watershed**. Go over the



Yellow Lampmussel

key points from the Student's Information, stressing that some sediment is natural, but that most of the heavy sediment we see in our streams is due to human activities. Have the students list several animals or plants which might be disturbed or killed due to heavy sediment loads. Then have them list ways that sediment could be controlled. Encourage students to suggest any personal actions they could take to decrease the sediment runoff into our waters.

Assessment:

Pencil and paper test-

1. What is the most important cause of water pollution in North Carolina today? (Sedimentation)

2. List three ways that sediment can enter a river or stream.

(Urban runoff, construction sites, timber harvesting, livestock overgrazing near water body)

3. Describe three ways to control the amount of sediment entering our rivers and streams.

(Vegetative buffer—leave a strip of plants along the banks of a river to capture sediment; ground cover—will hold soil in place; silt fence—will catch and trap sediment before it enters river; contour plowing—will prevent runoff from carrying soil down the hillside)

4. List two or more harmful effects that sediment has on aquatic life.

(Can decrease the amount of dissolved oxygen in water, can smother fish eggs, can cover rocks thereby reducing **habitat** for **insect larvae**, and can clog fish gills)

Modification:

If time permits, take a short hike upriver and measure sediment levels with the Imhoff cones at various sites along the Eno. Ask the park staff for trail suggestions. Also, look for possible origins of sediment.



McCafferty: Aquatic Entomology.
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Student's Information: Sediment: The "S" Word

Sedimentation and turbidity are the major causes of stream degradation in North Carolina today. Sediment clogs fish gills, destroys habitat needed for egg-laying, blocks sunlight, carries pollutants and buries plant life.

Sediments are solid materials, usually soil particles, that settle to the bottom of a river, stream or lake. As a rule, particles of silt, clay and organic materials settle to the river bottom, especially in impounded or slow-moving stretches of river. These settled particles (sedimentation) can accumulate and smother the eggs of fish and aquatic **insects** that were laid on the river bottom. Sediment settles into spaces between rocks making these microhabitats unsuitable for mayfly nymphs, stonefly nymphs, caddisfly larvae and other aquatic insects which require such spaces.

Turbidity results from solids remaining suspended in the water. The water is no longer clear, but cloudy or muddy. Suspended solids vary, ranging from clay, silt and plankton to industrial wastes and sewage. They may come from soil erosion, waste discharge, and urban runoff from streets and parking lots. They also may be the result of excess nutrients,

for when too much phosphorous and nitrogen get into the water, an over abundance of **algae** may grow. Depending on the source(s) of the solids, turbid water may be almost any color: white, red-brown, green, gray, purple, etc.

At higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Waters become warmer as suspended particles absorb heat from sunlight. The higher the concentration of particles, the higher the water temperature rises, which means there is less oxygen available. Also, turbidity reduces the amount of light penetrating into the water which decreases photosynthesis. This in turn further reduces oxygen concentrations. Thus, fish and other aquatic creatures may die of suffocation.

Additionally, suspended solids may clog fish gills, reduce growth rates and decrease resistance to disease, as well as prevent egg and larval development.

Sediment: Where It Comes From

Sediment is the result of rain or other **precipitation** falling on exposed surfaces and carrying materials from them into streams and lakes.

Sediment occurs naturally in small amounts in any body of water. Natural erosion of river banks or shorelines is one example. However, humans add significantly to sediment loads in a number of ways. Road construction, timber harvesting, allowing livestock to over graze (so that the soil is bared), clearing land for buildings, and farming all can contribute to sediment problems in our water unless sediment control methods are used.

Sediment: Stop It from the Start

With appropriate control methods, sediment can be stopped before it becomes a problem. Here are several ways:

- 1. <u>Planning</u> anytime a project is planned near a body of water, appropriate sediment control methods should be included before the project starts.
- 2. <u>Buffer areas</u> leaving wide undisturbed strips of vegetation between a project and a body of water is essential in helping stop excessive sediment from reaching the water.
- **3.** "Silt fence" string a fine mesh net between the project and the body of wa-

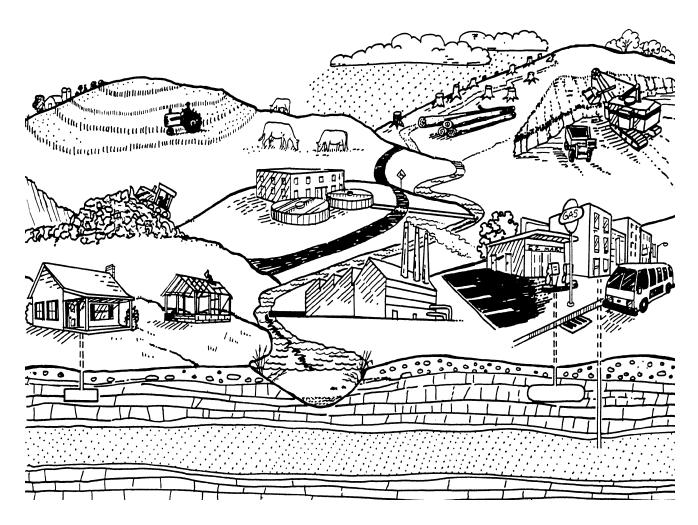
Eno River State Park, NC 4.3.3 May 2000

ter. When this fence is erected properly, it can trap a lot of sediment.

4. Ground cover — after initial clearing for a project, all exposed areas should be seeded with grass or planted with some other ground cover and covered with straw to prevent the soil from being washed away.

- 5. Contour farming farmers can plow with the contour of the land and leave buffer areas along the edges of their fields. They can also try to keep cover crops on exposed soil to minimize erosion.
- **6.** Prevent Overgrazing livestock should be moved at the first sign of erosion. The

number of animals should not be more than an area can handle. Buffer areas along water should be fenced. Watering areas should be located where the banks are not steep. These watering areas should be fenced off and new areas should be used when erosion becomes a problem.



Credit: Tennessee Valley Authority. 1993. Environmental Resource Guide—Nonpoint Source Pollution Prevention.

Major Concepts:

- Water quality
- Indicator species
- Adaptations
- Ecosystem
- Energy flow

Learning Skills:

- Observing, using numbers, classifying, inferring and predicting
- Reading informational materials; using keys and identification guides
- Calculating stream index values

Subject Areas:

- Science
- English Language Arts
- Mathematics
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Special Considerations:

See the safety message in Introduction on page 1.3.

Location: Fews Ford

Group Size:

16 students, 2 adults

Estimated Time: 1 hour

Appropriate Season:

April to October

Materials:

Provided by park:

kick net, seine net, dip net, wide mouth plastic jars, aquaria, plastic tubs, clipboards, maker board, field guides, laminated fish keys, laminated invertebrate key, aquarium nets, plastic spoons, glass dishes, table, life jackets, extra activity sheets, examples of adult macroinvertebrates

Provided by the educator: worksheets, pencil (one per student)

Note: Make sure participants bring a complete change of clothes. They should also wear clothes and shoes that they don't mind getting wet and/or dirty.

Objectives:

- Describe 3 characteristics of aquatic macroinvertebrates that help them survive in aquatic habitats.
- Using keys and field guides, identify 3 macroinvertebrates in the field.
- Name 3 indicator species and explain how they are used to determine water quality.
- Calculate the stream index rating for a river.
- List and describe 5 factors necessary for a healthy river ecosystem.

Educator's Information:

To prepare your students for their visit, we recommend they complete the two pre-visit activities in this EELE. The purpose of this activity is to introduce students to **macroinvertebrates** and aquatic **organisms** and how they can be used as **indicator species** to determine the health of the river.



The students will be involved in collecting macroinvertebrates in the river and must be dressed appropriately. Park staff will rope off the area where sampling will occur. Life jackets and a first aid kit will be available. Park staff will discuss safety considerations and the educator will assist in seeing that all safety precautions are followed. The students will work in groups of four or five, with one person recording the data. After completing the worksheet, students will gather and discuss their results with park staff.

Instructions:

1. Park staff will lead a brief discussion focusing on: macroinvertebrates (macros), what they are and why they are important; **metamorphosis**, what it is and how it is accomplished; and indicator species, what they are and how they are used to determine the health of a

river. Park staff will

also cover use of the

sampling equipment and safety precau-

tions that must be

followed.

2. Separate the students into groups of four or five and have them collect aquatic samples following all safety procedures.

3. After collecting samples, each group should identify the aquatic macroinvertebrates using the "Key to Common Macroinvertebrates." They should also use field guides to aid in identification. Have them record their answers on the "Aquatic Sampling Data Sheet" and use their results to determine the **Stream Index Value** (relative health) of the river.

The Stream Index Value places macros into one of three groups based upon how tolerant or sensitive they are to changes in water quality.

Group I – macros that are very intolerant to water pollution. The dominant presence of Group I species is an indication of good water quality. Group I is given an index value of 3.

Group II – macros that are moderately tolerant to a reduction in water quality. They are given an index value of 2.

<u>Group III</u> – macros that are tolerant to pollution. Their dominance indicates poor water quality. They are given an index value of 1.

The students will learn how to calculate the Stream Index Value by using the formula:

- (3 x # species in Group I)
- (2 x # species in Group II)
- + (1 x # species in Group III)
- Stream Index Value

4. After the students have identified their specimens and determined the Stream Index Value, park staff will lead a group discussion summarizing what they've learned, what they've identified from the river, and the importance of indicator species and the Stream Index Value.

Assessment:

Use the test at the end of this activity, or design one of your own.

Extension:

Back in the classroom, have students create different graphical representations of their field data. "Water, water every where nor any drop to drink" –so says the sailor in Samuel Taylor Coleridge's "Rime of the Ancient Mariner" as his boat is becalmed at sea. Fortunately, in our area, water is everywhere and there seems to be plenty to drink, at least for now. But that may be changing. Let's take a closer look at water and discover what a fragile and sensitive resource it is.

What is water? The dictionary defines water as a colorless, odorless transparent liquid occurring on earth as rivers, lakes, oceans, etc., and falling from the clouds as rain, snow, ice, etc. Water occupies more than 70 percent of the earth's surface, and it makes up approximately 60 percent of the human body. You may have heard the saying "Water is life." Think about it for a minute. Can you think of any living organism that does not depend on water?

David Quammen, in his book, *Natural Acts, A Sidelong View of Science and Nature* says, "Without life, there would still be water. Without water no life."

Water comes in many forms. To really appreciate it, you need to pick out one of its many forms and get to know it personally. For your visit to Eno River State Park, you need to know more about water in the form of a river.

What is a river? A river is defined as a natural flow of water which empties into an ocean, a lake, or another river. It is the result of springs, streams and creeks joining together to produce a larger volume of flow. These smaller bodies of water are called **tributaries**. The land that a river and its tributaries flow through is called a wa**tershed**. A healthy river must have a well-protected watershed because any kind of disturbance to the watershed has an effect on the river.

River as an Ecosystem

A river is an **ecosystem**. The plants and animals in the river, along with the physical surroundings of the watershed form an interdependent system. You might compare a river to a fine stew or soup. The various living or onceliving parts of the watershed are the ingredients for the stew or soup. Usually the more ingredients you add, the better the stew. A stew also needs spices to make it taste just right. In our analogy, the spices refer to the nonliving parts of the river ecosystem oxygen, minerals, sunlight, etc. If you try to make a stew with just one ingredient, or if

you leave out an important spice, your stew is not going to be good.

Here then is a recipe for a fine healthy river:

Some sunlight – just enough for the **algae**, moss, diatoms and aquatic plants to carry on **photosynthesis**. (Too much sun heats up the water and robs it of **dissolved oxygen**.)

<u>Fallen leaves</u> – they provide the main source of energy for a river system. In the fall, leaves drift down from the trees into the water where they soon sink to the bottom or get caught in logiams or wedged between rocks. At this point, bacteria and fungi climb aboard the leaves and begin to "munch out," causing the leaves to decompose and break down into smaller pieces. The half-eaten leaves, bacteria and fungi are eventually swept downstream where they provide food for munchers, grazers and filter feeders – the wonderfully adapted macroinvertebrates (macros), such as stonefly nymphs, mayfly nymphs, and caddisfly larvae. These organisms further break down the leaves into a very fine mulch called **detritus**. In addition to the munchers. grazers and filter feeders, there are other types of macroinvertebrates that prey on

other macroinvertebrates. Lots of different kinds of macros are a sign of a healthy river.

<u>Dissolved oxygen and</u> <u>carbon dioxide</u> – all the animals in the river need dissolved oxygen to breathe. These same animals breathe out carbon dioxide, which is essential for algae and other aquatic plants. These plants in turn take in the carbon dioxide and give off oxygen.

Aquatic plants and animals – aquatic plants like riverweed and water willow provide cover for macros and small minnows. All the aquatic animals in the river provide food for each other and non-aquatic animals in a complex **food web**. When all these various plants and animals die or excrete waste, they return essential nutrients that were borrowed so that they could live.

Various minerals – the fine spices of a river include calcium bicarbonate, potassium, nitrates and phosphates. These ingredients help balance a river's **pH**; provide building material for the shells of snails, **mussels**, clams and crayfish; help fish breathe more efficiently; and act as natural fertilizers essential for aquatic plants.

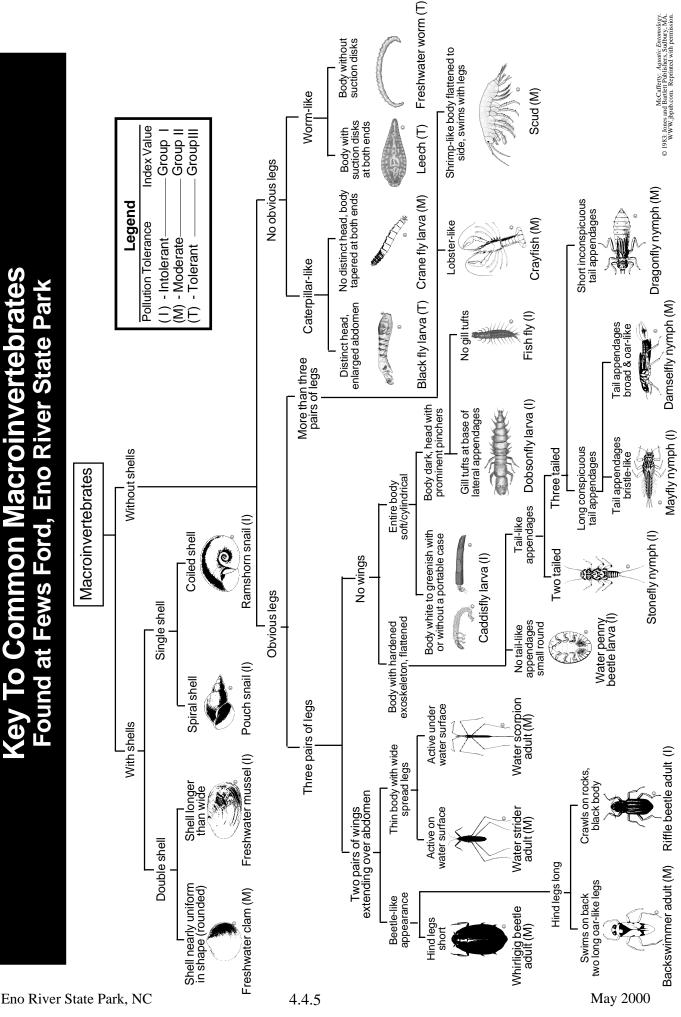
These are just the minimum ingredients needed for a healthy river. A river needs only natural ingredients; unnatural ingredients can have a bad affect on a river. David Quammen sums up what makes a healthy river when he talks about a trout stream. "A good trout stream must first be an excellent **insect** stream, a superior haven for algae and fungi and bacteria, a prime dumping ground for

dead leaves, a surpassing reservoir of oxygen and calcium. It will then also. and thereby, be a good osprey stream, a favorite among otters, a salvation to dippers and kingfishers and bank swallows and heron, mergansers and Canada geese and water shrews, mink and muskrat and beaver. Not to mention the occasional grizzly bear. And who knows but that, sometime, a human might want to drink."

If there are plentiful numbers of many different **species** of plants and animals in a river, then we have a healthy river. Taking samples of these aquatic plants and animals is a means to monitor the quality of a river's waters.



Key To Common Macroinvertebrates Found at Fews Ford, Eno River State Park



Worksheet for On-Site Activity #4

Aquatic Sampling

Name:	Date:
Location:	Temperature: AirWater
Methods used to sample:	Stream Index Value:

Instructions:

Use the "Key to Common Macroinvertebrates" or "Pollution Tolerance of Macroinvertebrates" chart to identify organisms. Record the species of organisms found in the space below, using the chart to classify them by their tolerance levels. (See example below.)

Group I	Group II	Group III
1.	<u>1.</u>	<u>1.</u>
<u>2.</u>	<u>2.</u>	2.
3.	3.	3.
4.	4.	4.
<u>5</u> .	5.	5.
6.	6.	6.
7.	7.	7.
Total =	Total =	Total =

Calculate the Stream Index Value by multiplying the number of species of organisms in each group by the index value for that group. Then, add the resulting three numbers to obtain the Stream Index Value (see example below.)

(3 x no. of species - Group I)	Cumulative Index Values	Stream Index Rating
(2 x no. of species - Group II)	23 and above	Excellent
+ (1 x no. of species - Group III)	17 to 22	Good
= Stream Index Value	11 to 16	Fair
- Stream maca variat	10 to less	Poor

EXAMPLE:

Group I 1. stonefly 4. rij	Group II ffle beetle 1. dragonfly		roup III . <i>black fly</i>	
- ,	addisfly 2. crayfish		. freshwater worm	
3. mussels 6.	<u>3.</u>	3.	,	
(3×5)	+ (2 x	(2) +	(1×2)	= 21

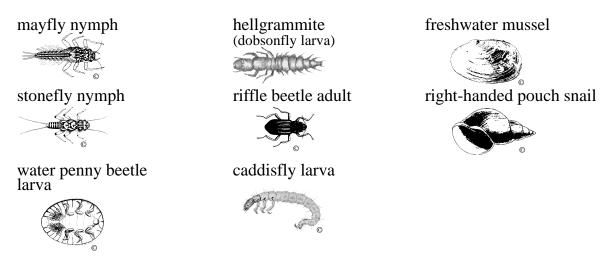
[21 is the stream index value, which is a good rating according to the chart above.]

Adapted from <u>A Field Manual for Water Quality Monitoring</u>, An Environmental Education Program for Schools by Mark K. Mitchell and William B. Stapp.

Pollution Tolerance of Macroinvertebrates

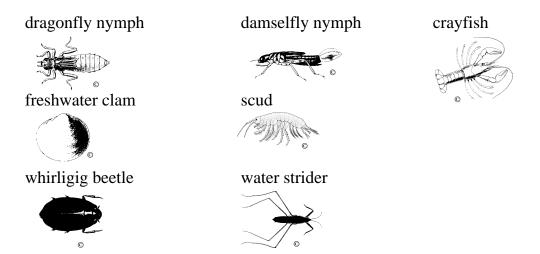
Group I - Index Value = 3

These macroinvertebrates cannot tolerate pollution or changes in water quality. Their presence or dominance generally indicates good water quality.



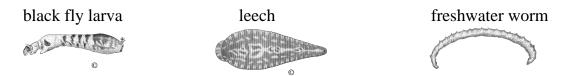
Group II - Index Value = 2

These macroinvertebrates can exist in a wide variety of water quality conditions.



Group III - Index Value = 1

These macroinvertebrates can exist in polluted water. Their dominance indicates poor water quality.



McCafferty: Aquatic Entomology.
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Name:		Date: _				
dragonfly nymphs, da fish, mayfly nymphs	amselfly nympha and black fly lar	s, freshwater clams, frage. Use the "Pollut	e following macroinvert reshwater worms, scud- tion Tolerance of Macro wels and record below:	s, cray-		
Group I	Group I Group II			Group III		
1.						
2.	<u>2.</u>		<u>2.</u>			
3.	3.		<u>3.</u>			
<u>4.</u>	4.		4.			
<u>5.</u>	<u>5.</u>		<u>5.</u>			
Total =	Total =	=	Total =			
Calculate the Stream (3 x no. of species - (2 x no. of species - + (1 x no. of species - = Stream Index Val	Group I) Group II) Group III) ue	Cumulative Index Values 23 and above 17 to 22 11 to 16 10 to less	Stream Index Rating Excellent Good Fair Poor			
	ndex Rating? _ ngredients) nee east two <u>nonlivi</u>	eded for a healthy ri				
1						
1						

On the back of this paper, list three macroinvertebrates and, for each one, describe an adaptation that allows it to live in a particular aquatic habitat.

Answer Key for Test for On-site Activity #4

Group I	Group II	Group III
1.Mayfly nymphs	1. Dragonfly nymphs	1. Black fly larvae
<u>2.</u>	2. Damselfly nymphs	2. Freshwater worms
3.	3. Freshwater clams	3.
4.	4. Scuds	4.
5.	5. Crayfish	5.
Total = $3 \times 1 = 3$	Total = $2 \times 5 = 10$	Total = $1 \times 2 = 2$

Stream Index Value = <u>15</u> Stream Index Rating = <u>Fair</u>

Ingredients for a Healthy River Ecosystem: (in any order)

- 1. **Sunlight** makes photosynthesis possible. Plants need sunlight to live. Oxygen, a by-product of photosynthesis, is needed by animals in order to breathe.
- 2. **Dead leaves (detritus)** are the main energy source for the ecosystem (base of food web). Smaller organisms feed on this and are eaten by larger organisms.
- 3. **Various minerals** are necessary for plants to grow (fertilizers) and for animals to make shells and/or some kind of skeleton.
- 4. **Aquatic plants and animals** Plants provide food and shelter for animals. The animals and plants are interrelated through a complex food web. The greater the diversity of organisms, the healthier the river is (indicates excellent water quality).
- 5. **Dissolved oxygen and carbon dioxide** oxygen is needed by animals. Carbon dioxide is needed by plants in order to carry on photosynthesis.

On the back of this paper, list three macroinvertebrates and, for each one, describe an adaptation that allows it to live in a particular aquatic habitat.

Sample Responses:

- 1. Mayfly nymph (or damselfly nymph) has gills that allow it to take dissolved oxygen from the water.
- 2. Water penny (or stonefly nymph) has special adaptation allowing it to cling to rocks so that it can live in fast-moving streams where there is abundant dissolved oxygen.
- 3. Freshwater clam (or mussel) has hard shell to protect it. Uses siphons to take in river water and filter out food particles.

Post-Visit Activity #1

Fragile Waters

Major Concepts:

- River basin
- Water quality
- Air quality
- Land use planning
- Resource management

Learning Skills:

- Observing, communicating and predicting
- Problem solving, respecting differences, working in groups
- Expanding on ideas, recognizing bias and persuasive techniques

Subject Areas:

- Science
- Social Studies
- English Language Arts
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location: classroom

Estimated Time: one to three 45 minute periods

Appropriate Season: any

Objectives:

- List two animal species endemic to the Neuse and Tar river watersheds.
- Evaluate the effects of different imaginary land uses on the Eno River watershed.
- List and discuss five ways to minimize damaging effects in the Eno River watershed.

Materials:

Provided by educator: Per student:

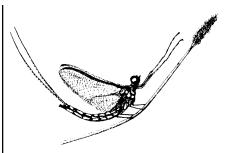
One copy of Student's Information and Special Species Fact Sheet

Per three students:

Scissors, masking tape, paste or glue, paper, Legend and Land Use Cutouts, Topo Map of the Upper Eno River Basin, Eno River to the Pamlico Sound

Credits: "Dragonfly Pond," Project WILD Aquatic Education Guide—1987, 1992. Council for Environmental Education. Adapted with permission from Project WILD. In North Carolina, Project WILD is part of the N.C. WILD environmental education program. For information about N.C. WILD, contact the N.C. Wildlife Resources Commission, Division of Conservation Education, 1712 Mail Service Center, Raleigh, NC, 27699-1712

- Balance the need to protect water quality with economic and other concerns while working with a group to arrange land use cutouts on a map.
- Give at least two examples of how air and water quality are connected.



Educator's Information:

very human use of land Ein the Eno River water**shed** has a positive or negative effect not only on the Eno River, but on the water. wildlife and people from here to the Pamlico Sound. What we do with land is a reflection of our priorities and lifestyles. The search for a modern day "good life" and all its conveniences produces mixed results for plants, animals, water quality and people in the Eno watershed. Some people see our natural resources as little more than raw material for human use. Others believe that the natural environment is to be preserved without regard for human needs. Still others yearn for a balance between development and protecting our resources. Very real differences of opinion regarding these issues exist between well meaning people.

At the core of land use issues is the concept of growth. Growth in natural

systems has inherent limits, imposed by a dynamic balance of energy between all parts of the system. Energy in natural systems is translated into food, water, shelter, space and continued survival. This means that the vitality of natural systems is expressed by their ability to be self-regulating. This capacity for self-regulation makes it possible for all natural members of an eco**system** to live in harmony. All life forms of any ecosystem must be considered. The macroinvertebrates in the water are just as necessary to a **habitat** as the plants and fish. It is this natural dynamic balance, with all its inherent and essential parts, that much of human land use has tended to disturb.

Human activities often go beyond the natural limits of a setting. Humans have the ability to import energy sources that allow a system to exceed its natural limits or to remove energy sources that are necessary for a system to stay in balance. For example, people can dam rivers to provide power, drinking water and irrigation. Water from the river can be used in factories. mills, sewage treatment and other industries that need large amounts of water to produce certain products. Combustion of fossil fuels and vaporization of animal wastes add nitrogen to the air which eventually finds its way into our waters. All of these activities affect life in the Eno River watershed.

The purpose of this activity is to encourage students to wrestle with development, local economy and resource management issues. The students will use the Eno River watershed as a microcosm of environmental concerns in making management decisions. They will contend with the arrangement of overlapping and conflicting land uses in an effort to preserve the Eno River watershed. When the students reach some kind of agreement about local issues, they will discuss how what they have done affects the river downstream. The activity ends with the idea that the planet is, in fact, a single river watershed.

Instructions:

1. Prepare copies of the Legend and Land Use Cutouts sheet, the Topo Map of the Upper Eno River Basin, the Student's Information, and the Special Species Fact Sheet. Explain the activity. Tell the students that they will be responsible for arranging the pattern of land use around the Eno River to minimize the impact on the river. Remind them that some of the land uses might be conflicting and therefore they will have to make some

very tough management decisions. Ask students to read the Student's Information and Special Species Fact Sheet.

2. Divide the class into groups of three to five, with each group representing one of the interest groups (below) or taking on the role of the town commissioners. Students will stay in these groups until the end of the activity. Each group must decide where to place all the land uses.

Possible interest groups:

- Residents people who want to live there.
- Farmers want to use the land to raise food.
- Businesses want to use land for commerce and growth.
- State park wants to preserve and protect watershed for plants and wild life, recreation, drinking water and historic sites.
- Highway department wants to build a bypass road to ease traffic congestion in town.
- Textile factory wants to construct a huge factory that would provide 500 jobs and boost local economy.
- School representatives want to build a new
 school to accommodate
 more students due to
 rapid growth of the town.
- Hospital representatives propose building a new hospital to service the

- community in the future because of expected growth and development in the area.
- County and state representatives believe it is essential to have a bigger landfill and a newer, more efficient wastewater treatment plant.
- 3. Give each group a copy of the Topo Map of the Upper Eno River Basin and the Legend and Land Use Cutouts page. Read the following text to your students:

You will be using an enlargement of an actual topographic map of the upper Eno River basin. Topographic is derived from Greek words *topos*, meaning place, and graphein, meaning to write or draw. Thus, a topographic (topo) map is a drawing or pricture of a place. One feature on a topo map is contour lines. Contour lines are thin lines that indicate the contour of the land and its elevation. The distance between contour lines on your map is 10 feet. Where the lines are very close together, there is steep terrain. Level terrain appears where contour lines are further apart. In this activity, the steepness or flatness of the terrain will dictate where certain land uses can occur. For example, you would not put a landfill on a steep ridge. A legend explaining other map symbols is included on the Legend and

Land Use Cutouts page.

Spend some time discussing features and symbols on the topo map. Practice locating ridges, summits, rivers, highways, etc. Then read the following text aloud:

Note: There are two **species** of plants and three species of animals on the map where they might naturally occur. These species are either state protected or have special habitat requirements. The purpose of placing these on the map is to make the decisions more realistic. Information on these species is given on the Special Species Fact Sheet.

- 4. Have the students cut out the land use pieces from the Legend and Land Use Cutouts page. When they fasten the cutouts to their topo map, suggest that they use small loops of tape. This will allow them to change their minds before they paste them down.
- **5.** Place the following rules on the chalkboard:
 - all land use cutouts must be used; the cutouts may be cut smaller
 - cutouts may touch, but may not overlap
 - no cutout, except for the state park, can touch or cover a "Special Species" circle
 - except for the state park and the vegetable farm, all cutouts must touch a

- new or existing road
- vegetable farm and landfill must be on relatively level land
- both textile factory and wastewater treatment plant must touch the river
- no cutout can touch or cover an existing building
- 6. Once the students have cut out the necessary materials and are ready to make land use decisions, have them create a list of pros and cons for each land use. Guide the class discussion so the consequences of each land use are considered. Record these on the chalkboard.
- 7. Have the students work in their groups long enough to begin to seriously grapple with the challenge.
- **8.** Invite each group to display and describe their work in progress. Encourage discussion of their choices. In the discussions emphasize:
 - no land use can be excluded
 - wildlife habitat must be preserved
 - everyone within their small group must agree

Discuss how their plans will impact the various interest groups.

Look for the consequences of their proposed land use plans. Be firm about this being a very difficult set of choices. Remind them that for certain habitats this is a "no-win" situation in many ways. The best that can be hoped for is that the land use plans will minimize the threats to the river and the special plants and animals.

Assessment:

- 1. Pass out the Eno River to the Pamlico Sound sheet. Have each group connect their topo map to the Eno River section of this sheet. Ask one group to describe their plan to the class. Then, have all the students brainstorm possible effects that this land use plan could have on the water quality, air quality, and people downstream. For example, you could emphasize the **effluent** (and/or smoke and fumes) from the textile factory. How will it be treated? Where? By whom? Where will it go? What effect will it have on air and water quality in the river basin?
- 2. Ask the students to look again at all of the land uses in this activity. What could the people who are actually in charge of these various land uses do in their practices to minimize the damage to Eno River and the special species? Review technologies that were discussed in the on-site activities of this EELE, such as vegetative buffers and silt fences. In-

- clude other ideas that students may have heard about. For example, some industries have developed new technology that allows them to remove harmful waste using a scrubbing filter. Maybe such a filter could be used on their textile factory. Some communities have used new technology to collect methane gas (a common gas generated by decomposing garbage) from landfills and use it as a source of energy.
- 3. Ask the students to create a list of things they, personally, can do to begin to reduce the potentially damaging effects of their own lifestyles on the downstream habitats. If possible invite them to report periodically, throughout the school year, on their progress in carrying out these new practices. Discuss the concept that all the waters of the planet are, in fact, part of a single Eno River.
- 4. Display all the final land use plans for everyone to see and discuss. Analyze the merits of each of the approaches. Ask each student to write a paragraph stating which land use plan would have the least harmful effect on the Eno River (or Neuse River Basin) and why. In addition, ask them to describe at least three things that could be done to further minimize the damage to water quality in the river basin.

Extensions:

- 1. Review the Neuse River Basin map from Pre-visit Activity #1. Call the Division of Water Quality at (919) 733-5083 for a copy of the Neuse River Basinwide Water Quality Management Plan.
- 2. Take a field trip to Cliffs of the Neuse State Park near Goldsboro to collect similar data on the river the Eno feeds into, the Neuse. For more information contact:

 Cliffs of the Neuse St.Park 345-A Park Entrance Road Seven Springs, NC 28578
- **3.** Collect newspaper articles on local water and land related issues as a current events activity.

(919) 778-6234

- **4.** Learn more about environmental impact statements. Try to obtain actual statements concerning land use in your area. See what concerns are addressed in these documents.
- **5.** Find out about zoning laws and land use regulations in your area. Would the plans the student groups proposed for the upper Eno River be allowed in your community?
- **6.** Send a representative sample of the students' land use plans to the park. (We would appreciate the feedback.)

The **watershed** for the ■ Eno River is located in an area that is growing rapidly. Home owners and industries are spreading out from our cities into the country. Business and industry seek undeveloped land to use and help our local economy by creating new jobs. This is good but sometimes development conflicts with protecting the river and the special species that live in the watershed. This is where different people have different ideas about how to best use the land, air and water in the Eno River watershed and still insure that the Eno River is clean.

Think back to your visit to the Eno River. We know that the Eno provides drinking water for Hillsborough and Raleigh. We know that water is taken from the Eno for **sewage** treatment, **irrigation** and use in industry.

Many different forms of recreation are enjoyed in the Eno River watershed. The Eno River and its watershed provide crucial **habitat** for many plant and animal species. The Carolina madtom (a catfish) and the Neuse River waterdog (a salamander) are two animals that are endemic to the Tar and Neuse river basins, of which the Eno is part. Endemic means they are found in these river basins and nowhere else on earth! The panhandle pebblesnail, a tiny and very rare snail, appears to be endemic to just the Eno River.

During your visit to the park, you explored various types of water quality problems, such as **sedimentation** and changes in stream flow. Some threats to water quality are not as obvious. For example, in eastern North Carolina, atmospheric nitrogen accounts for at least 25% of the

new nitrogen added yearly to our waters. (Atmospheric nitrogen comes from fossilfuel combustion in cars, trucks, power plants and industries, as well as vaporization of wastes from agriculture and wastewater treatment plants.) All this extra nitrogen stimulates the growth of algae and can result in fish kills. Atmospheric nitrogen also contributes to acid rain. When evaluating the health of our rivers, we shouldn't forget that air, land and water quality are all closely linked.

So how do we make land use decisions that will benefit the local economy and still protect our air, water and other natural resources? The following activity is designed to give you a taste for how difficult the decision-making process can be.



Special Species Fact Sheet



Yellow lady's-slipper orchid

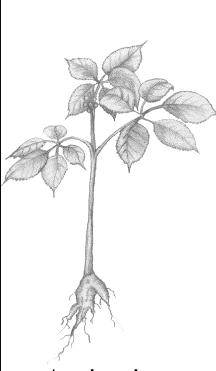
A rare wildflower in this area, it requires soils that are close to a neutral **pH** (most soils in our region are acidic) and a mature tree canopy to give partial shade. It takes a minimum of 15 years for this orchid to grow from seed to a flowering plant.



The Freshwater Fishes of North Carolina.
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Carolina madtom

This **endemic** catfish is found only in the Neuse and Tar river basins. It prefers shallow water with little current over a sandy bottom. The Neuse River population is listed as "special concern," which means it has legal protection status in North Carolina.



American ginseng

This medicinal plant has been over-collected to sell in this country and overseas. Ginseng is very rare in this area and is becoming rare in the mountains where it was once plentiful. It has been used for centuries for its reported medicinal powers.



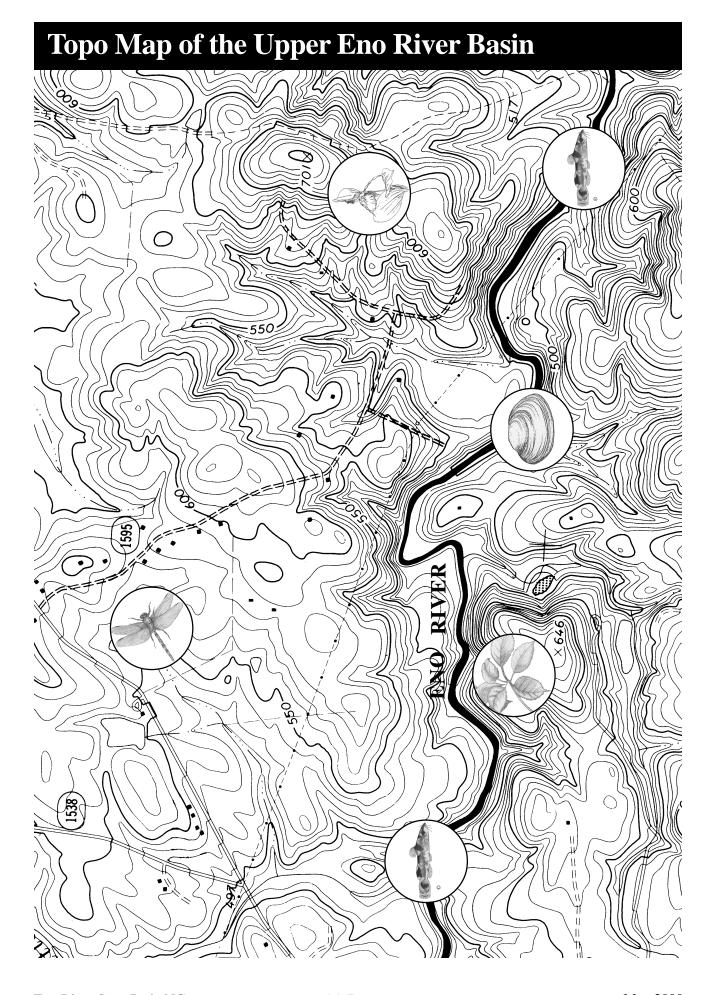
Thorey's grayback dragonfly

This dragonfly has very special habitat requirements. It needs wet seeps or marshy areas near springs to raise its young. This dragonfly hunts mainly in the forest instead of over water like most other dragonflies.



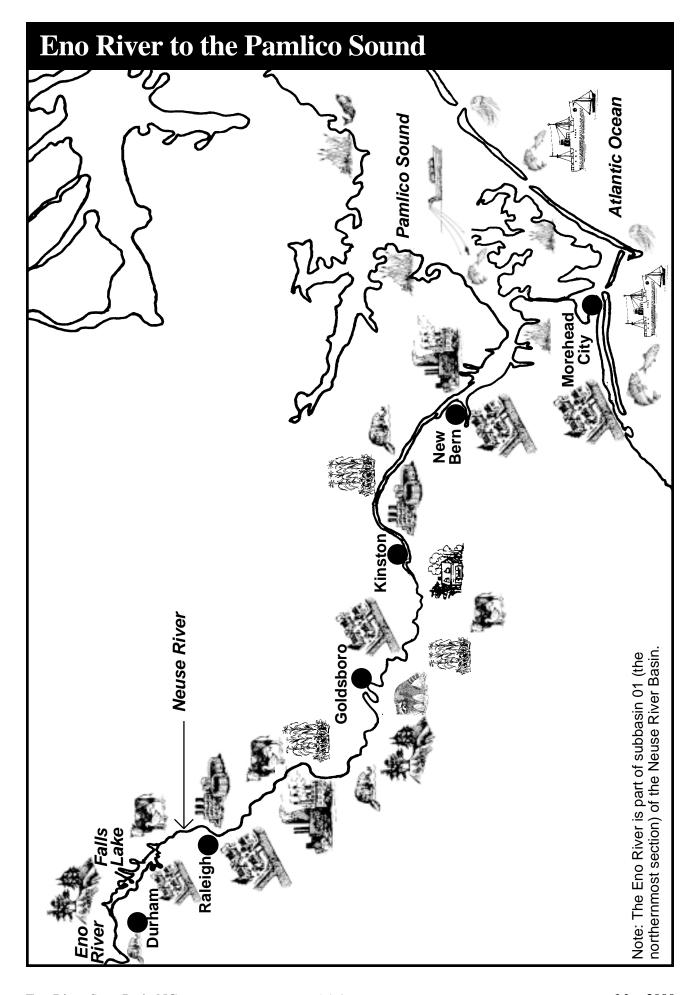
Yellow lampmussel

Almost all **mussels** require clean water to live in. Since the lampmussel is a filter-feeder, it passes large volumes of water through its system to strain out its food. If the water in which it lives is polluted, the pollutants can become concentrated in the mussel's tissue and kill it, or impair its ability to reproduce. The presence of this mussel in a river is an indicator of good water quality.



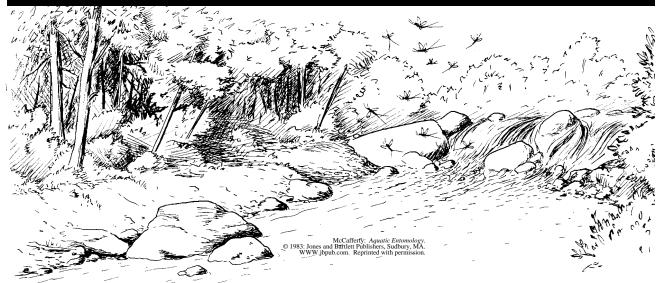
Legend and Land Use Cutouts

LEGEND FOR TOPO MAP **Building** Light-duty road **Elevation heights —**550**—** Unimproved road _ _ _ _ _ _ **Summit symbol Topo lines** (10 ft. intervals) **Power line ROAD** DRY GAS STATION **CLEANERS SHOPPING** OFFICE COMPLEX MALL **GROCERY** WASTE WATER **TREATMENT PLANT FIRE VEGETABLE FARM STATION SCHOOL TEXTILE FACTORY** LANDFILL STATE PARK HOSPITAL



Post-Visit Activity #2

Troubled Waters



Major Concepts:

- Water pollution
- Environmental issues
- Stewardship
- Environmental sustainability

Learning Skills:

- Communicating, inferring, predicting
- Problem solving
- Creative Writing

Subject Areas:

- Science
- English Language Arts
- Social Studies
- * See Activity Summary for a Correlation with DPI objectives in these subject areas.

Location: Classroom

Estimated Time: Two or more 45 minute class periods.

Appropriate Season: any

Materials:

Provided by educator: Per student: Student's Information and "Troubled Waters" **Credits:** "Something's Fishy Here," Project WILD Aquatic Education Guide—1987, 1992. Council for Environmental Education. Adapted with permission from Project WILD. In North Carolina, Project WILD is part of the N.C. WILD environmental education program. For information about N.C. WILD, contact the N.C. Wildlife Resources Commission, Division of Conservation Education, 1712 Mail Service Center, Raleigh, NC, 27699-1712.

Objectives:

- Identify two potential cause and effect relationships involving aquatic pollution.
- List and evaluate two alternative solutions to problems with aquatic pollution.
- Create an action plan to reduce pollution and improve the sustainability of a river, stream, pond or other water body.

Instructions:

- 1. Have the students read the Student's Information. Focus on **environmental sustainability** and how water pollution interferes with the ability of a water body to sustain life—for people as well as other living things.
- **2.** Have each student read the story "Troubled Waters." After the students have finished



reading, discuss the story with them. Ask them to think about as many different endings to the story as possible. Ask each student to write an ending to the story.

- 3. Divide the class into small groups. Have each group discuss how they think the story should end, sharing the ending they wrote. Ask each group to present one or more of their endings to the rest of the class. List the essential points of each ending on the chalkboard.
- 4. Discuss which ending(s) best illustrate environmental sustainability. Identify cause and effect relationships. Look for possible relationships between the story and problems regarding water use in the Eno River watershed or an aquatic habitat in your community.
- **5.** Next, have the students generate a list of possible aquatic problems that they believe exist in their community. Go through the list, noting which problems they might be able to solve. For example, pollution in a nearby brook is far more realistic for them to address than an entire **river basin**. It is important that the students be able to experience some success in developing a plan to tackle the problem. Have them form groups that have a common interest in one or more of the "solvable" prob-

lems and develop an outline listing steps on how to find out more about the problem. Once they have developed this outline, have each group report back to the class. Or, decide on one problem and work on it as a class.

- 6. If several groups outlined separate problems, ask the class to select the problem they would most like to address. Assure them that choosing one does not make the others less important. To be most effective in solving a problem, it helps for everyone to get behind one effort. Remind the students to develop an attitude for a clean, sustainable environment. Have them seek solutions rather than only place blame.
- 7. Once a specific issue is chosen, have the class list 10 things that can be done to make that problem less damaging to aquatic habitats. Focus on environmental sustainability how can the problem be solved so that the aquatic habitat can sustain life for years to come?
- **8.** Act as facilitator to the class by helping them develop an action plan. Establish a time line and specific assignments.
- **9.** Once the students have implemented their action plan, or have completed a project, please send a brief summary report to the park

so that we can share your efforts to clean up local aquatic areas with other groups.

Assessment:

- 1. Ask students to write a brief story describing the possible downstream consequences of the following events (or others of the teacher's own creation):
- A wastewater treatment plant has a failure and raw sewage enters a river.
- A forest is cut down to make way for a new shopping mall with large parking area. (It is located near a river's tributary.)
- A large freshwater wetland is drained for a new golf course.

Stories should show cause and effect relationships.

- 2. Next, ask the students to choose one of the events in question #1 and list two possible solutions to the water quality problem. Solutions should illustrate environmental sustainability.
- **3.** If the class, or a group of students has implemented an action plan, evaluate the success of this plan. What worked well? How could the plan have been improved?

Extension:

Find out if any Stream Watch groups or River Keeper groups are operating in your area. Invite a representative to come to your class and talk to the students.

Student's Information:

Troubled Waters

nvironmental pollution is an issue everywhere on the planet. Often individuals feel overwhelmed, helpless, and unable to do anything to help. Yet successful action to reduce environmental problems often starts through the actions of one individual. Students have initiated projects that improved the safety of neighborhoods, created parkland, and preserved major habitats for wildlife. When a group of individuals join together, the chances of solving problems increases. For example, Eno River State Park owes its creation to an individual who formed a group called the Association for the Preservation of the Eno River Valley.

The city of Durham wanted to build a reservoir that would have flooded the entire Eno River valley. By working together, the group was able to acquire some

land and sell the idea of a park to the state of North Carolina. As a result, Eno River State Park was born and the reservoir project was abandoned. All of this work originated from one person's decision to take action.

There is still much to be done to protect aquatic habitats in the Eno River watershed. Reducing or eliminating pollution is one area where individuals can make a difference. Significant aesthetic improvements can result from reducing two common forms of water pollution - litter and **sedimentation**. Other forms of pollution are harder to detect and control. Much work needs to be done to identify and eliminate sources of pollution in lakes, rivers, groundwater and oceans.

Pollution is a term that is, at times, difficult to define.

Even in nature, pure water cannot be found. When precipitation falls from the sky, it picks up carbon dioxide and other gases and becomes more acid and capable of dissolving some rocks. Water is known as the "universal solvent." This means that it can dissolve many kinds of substances. Water can also carry suspended particles (sediment) such as soil and plant material. These particles reduce the penetration of light into water which affects the plants living below the water's surface. Water temperature and the amount of dissolved gases also change over time and affect the aquatic life.

The presence of chemicals in water affects **organisms** differently, depending upon the chemicals' concentration. Some chemicals can be toxic to some organisms even at very low concentrations.



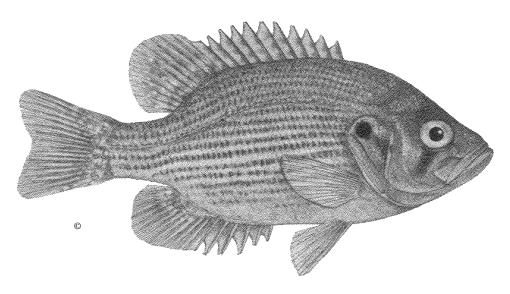
Scientists usually measure the concentration of materials in ratios, comparing the parts of the chemical substance to the parts of water containing it. When concentrations of materials reach critical levels, certain organisms die. **Macroinvertebrates** are especially sensitive to small changes in water quality.

Living things need the oxygen that is dissolved in water. When oxygen levels fall below certain points, organisms die. The warmer the water, the less oxygen it can hold. Some animals need more oxygen than others; therefore, warm water can be described as polluted for some kinds of organisms and not for others.

Water pollution is usually described in relation to the use humans make of the water in which the pollutant is found. For example, if conditions in the Eno River reach the point where Roanoke bass, a sought after gamefish, start to die, the river would be considered polluted. However, the river might still support other types of fish that can tolerate more pollution than a Roanoke bass. In other words, water could be described as polluted for some organisms and not for others. That's why it is important to know the river's legal classification. Classifications are assigned to the rivers of North Carolina based upon the existing or contemplated best usage of the various streams in the river

basin. When a river or stream no longer supports the intended or best use, it is considered "impaired." Then actions must be taken to restore the river.

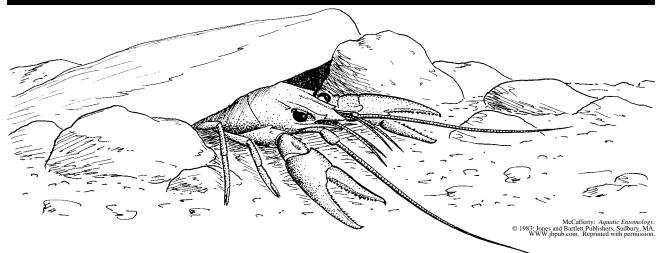
The purpose of this activity is to recognize that all of us can make a contribution to environmental sustainability in our own community. Environmental sustainability means the ability to meet the needs of the present without compromising the ability of future generations to meet their needs. We are all responsible for actions affecting life in the Eno River watershed, and other watersheds where we live and work. Let's help these waters sustain life for generations to come!



Roanoke Bass

The Freshwater Fishes of North Carolina. © 1991 Edward F. Menhinick. Reprinted by permission.

Troubled Waters



Merlin and Barre were brother and sister.
They lived in an old wooden house right beside the Eno River, just a little ways downstream from Hillsborough. Merlin was in the sixth grade and his sister Barre in the fifth.

Ever since they were able to walk, their parents had taken them down to the riverside to play. As they grew older, they discovered many wonderful things living in the river. With homemade nets and aquariums, they would spend hours catching and watching crayfish, water striders, stonefly nymphs, minnows, frogs and turtles. They learned how to handle and release these creatures without harming them or themselves.

Often in the spring and summer, the entire family would spend a day picnicking and fishing. Merlin liked to catch feisty Roanoke bass because they fought so hard. After admiring them, he would release them. Barre was the expert at finding and catching the biggest crayfish. She would also spend more time looking at the aquatic **insects** than Merlin. These bizarre animals were fascinating to her and she already knew the names of most of the common ones. The river provided endless opportunities for adventure. There was always something new waiting to be discovered.

Springtime was eagerly anticipated by Barre and Merlin. Spring meant warmer weather, fresh air, wildflowers and lots of new life in the river. This spring was especially important to Barre. Every year the fifth grade class had an environmental science fair. Students would choose a topic and develop a display to be judged at the fair. This year the theme for the fair was water quality. Barre had decided to learn more about aquatic insects and the kind of water

quality they needed to survive. She also planned to catch some aquatic insects to display alive in her aquarium at the fair. Merlin had promised to help her. With his help, she would have a good chance of winning the "Most Unusual Animal Display." Barre could hardly wait to go to the river and collect the aquatic insects for her display.

Finally, the day before the science fair arrived. Merlin and Barre walked down the short trail to the Eno River. Signs of spring were everywhere. Trout lilies, violets, and crested-dwarf iris were in bloom. Fresh new green leaves were unfurling on every tree and shrub. Butterflies and bees floated and buzzed in the clean warm air. Their hopes ran high; what a great day! They were sure to catch lots of neat aquatic insects. Merlin and Barre made their way down the slippery bank of the Eno and out onto a

gravel bar that stuck out into the river. The water was shallow here and moved swiftly over small rocks and gravel. Here they planned to pick up rocks and gently scrape the clinging insects off them. Merlin had a dip net to catch some minnows and water striders.

Barre eagerly started picking up rocks while Merlin tried to catch the minnows. The first rock she picked up had no insects on it, neither did the second or third rock. Merlin had not caught any minnows or even seen any water striders. Where were all the insects? They both looked around puzzled. Merlin then noticed some dead aquatic insects floating on the surface in a **pool** behind the gravel bar. Barre and Merlin looked around carefully and found hundreds of dead insects floating on the surface and washed up on the bank. There were even some dead minnows. It took a few moments to register. Barre forgot all about what this would mean for her science display. They both felt genuine concern. These fascinating animals that had provided them with hours of enjoyment were all dead! What could have happened? They soon realized that there was a mystery to be solved!

What would a Crime Scene Investigator do under similar circumstances? Right! Look for clues. Hundreds of aquatic insects don't keel over from fear of being exposed in public at a science fair! There had to be a really good reason. Barre and Merlin were determined to discover the answer.

A quick glance over the surrounding area revealed little evidence of foul play. Merlin did note that there was a condition common to all of the dead aquatic insects. They were slippery to the touch and seemed to be coated with a soapy substance. Barre saw the foamy suds first. The suds were clinging to the rocks and collecting in the still waters of the deeper pool upstream. They started upstream searching for more clues. Beyond the deep pool the suds were scarce. Carefully they moved further upstream until they came to where the river flowed through town. Beyond this, a new blacktopped parking lot sporting a brand new mini-shopping mall, signaled the edge of the town. There they discovered something new. Under fresh packed soil, tucked beside the fence. storm drains were partially buried. They were opened to allow flow of water into the Eno.

That night at dinner Barre and Merlin talked with their parents. They decided to

map the area of the new shopping center and identify the stores that might have soap in their waste water.

Merlin and Barre sat down and compiled a list of the shopping center's stores. They produced several possibilities – Floyd's Cleaners, Davis' Wash and Dry Laundromat, Geiger's Car Wash, and Tillotson's Auto Body. They decided to record observations on a daily basis for a week. They agreed to take turns looking for evidence. (Good detectives keep records, note patterns and follow trails before they draw conclusions or make accusations.)

One evening when it was Barre's turn to observe, her mother drove her to the shopping center. What she found made her very excited. When she got home she rushed into Merlin's room and cried, "We've got them! When Mom drove me to the shopping center we drove over a big bump in the parking lot near the car wash. They have a big black hose running into the drain pipe. They connect it after dark! I saw it - I know it! They let it flow into the storm drains from their storage tanks. That's where the soap is coming from! We gotta do something Merlin! Where do we go? What do we do?"

VOCABULARY

Acid – having a pH less than 7; the chemical state of water or other substance in which the hydrogen (H⁺) ions exceed the hydroxyl (OH⁻) ions. For example, a car's battery acid has a pH of 1. See pH scale.

Acid Precipitation (including **Acid Rain**) – any form of precipitation that is acidic as a result of mixing with sulfur or nitrogen compounds in the atmosphere. Sulfur and nitrogen compounds can come from coal burning power plants and car emissions.

Adaptation – a change in the structure or activity of an organism that produces a better adjustment to its environment, thus enhancing its ability to survive and reproduce. For example, the flattened, oval shape of the larva of the riffle beetle (called a water penny) is an adaptation that helps it cling to the surface of rocks in swift flowing waters.

Aeration – the process of exposing to the air or of causing air to circulate through.

Algae – primitive one-celled or multi-cellular plants that contain chlorophyll, but have no true root, stem, or leaf. Normally found in water or damp places.

Algal Bloom – a heavy growth of algae in and on a body of water, usually resulting from high nitrate and phosphate concentrations entering water bodies from farm/lawn fertilizers and detergents. Phosphates also occur naturally in some rock formations.

Alkaline – see Base.

Ammonia – a colorless, strong smelling gas composed of nitrogen and hydrogen. (pH = 12)

Anatomy – the branch of biology that deals with the structure of plants and animals.

Aquatic Life – a plant or animal growing or living in or upon water.

Average – the numerical result obtained by dividing the sum of two or more quantities by the total number of quantities; for example, 2 + 4 + 6 + 8 = 20 and 20/4 = 5; therefore, 5 is the average of the four numbers.

Base – having a pH greater than 7; the chemical state of water or other substance in which the hydroxyl (OH⁻) ions exceed the hydrogen (H⁺) ions. For example, soap has a pH of 10. See pH scale.

Biochemistry – the branch of chemistry that deals with the life processes of plants and animals.

Biology – the science that deals with the origin, history, physical characteristics, life processes and habits of plants and animals.

Classification – the grouping of organisms into categories based on shared characteristics or traits. For example, any animal that has feathers is considered a bird and placed in the Class Aves. Furthermore, if the bird has its eyes in front rather than on the side of its head, it is a member of the Order Strigiformes (the owls).

Community – a group of plants and animals living in a specific region under similar conditions, and interacting with each other through food webs and other relationships.

Contour Lines – thin lines found on a topographical map that indicate elevation. They show the contour of the land.

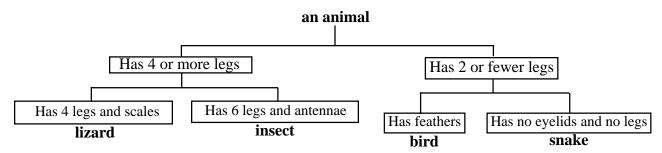
Decomposer – an organism whose feeding action results in decay, rotting or decomposition. The primary decomposers are bacteria and fungi. They are very important parts of a healthy ecosystem.

Decomposition – to rot or to break apart into basic components. Decomposition makes nutrients, such as nitrogen and phosphorous, available for use by other organisms.

Delta – a usually triangular alluvial deposit at the mouth of a river.

Detritus – dead organic matter, such as fallen leaves, twigs, and other plant and animal material that exist in any ecosystem.

Dichotomous – divided into two parts, groups or classes, such as a dichotomous key. Using a dichotomous key, one can identify an unknown organism by following the one branch of each pair that better describes the organism.



Distribution – the act of scattering or spreading out; the geographic range of an organism.

Dissolved Oxygen (DO) – the amount of oxygen gas molecules dissolved in water. Fish and other aquatic animals depend on DO for respiration.

Ecosystem – plants, animals and their physical surroundings that interact with environmental conditions, such as temperature and rainfall, forming an interdependent system.

Effluent – a liquid flowing out. The outflow of a sewer, septic tank, etc.

Endangered Species – a species that verges on extinction in all or part of its range.

Endemic – found only in a particular region or area. For example, the Carolina madtom is a species of catfish found only in the Tar and Neuse rivers. Thus, it is endemic to the Tar and Neuse rivers.

Environmental Sustainability – the ability to meet the needs of the present without compromising the ability of future generations to meet their needs.

Erosion – the process by which soil particles are carried away by wind, water, freezing and thawing, or a combination of these factors.

Estuary – semi-enclosed area where fresh water from rivers meets salty water from the sea. Example: The Lower Neuse River Basin from New Bern to the Pamlico Sound.

Eutrophication – naturally-occurring changes that take place after a water body receives inputs of nutrients, mostly nitrates and phosphates, from erosion and runoff of surrounding lands; this process can be accelerated by human activities.

Evaporation – the natural process by which water changes into vapor.

Food Chain – the transfer of energy and material through a series of organisms as each one is fed upon by the next. For example:

Detritus —> caddisfly larvae —> sunfish —> otter

Food Web – the interlocking pattern of food chains which exist in an ecosystem.

Habitat – the environmental conditions of the area where a plant or animal naturally grows or lives; its environment.

Indicator Species – an organism whose presence or absence in a particular environment can be used to determine the health of that particular environment.

Insect – any animal in the Class Insecta. Has a head, thorax, abdomen, and three pairs of legs on the thorax. As adults they usually have one or two pairs of wings attached to the thorax.

Irrigation – the pumping of water from ponds, lakes, or rivers through pipes or canals to supply crops with water during dry periods.

Key – an ordered list of significant characteristics of a group of organisms used to identify unknown species.

Larva – (larvae, plural) the immature form of an animal that changes structurally when it becomes an adult, usually by complex metamorphosis.

Latitude – measured in degrees, the distance north or south from the equator. For example, Durham is at 36° N latitude.

Longitude – the distance measured in degrees east or west of the prime meridian (0° longitude) at Greenwich, England. Durham is at 79° W longitude.

Macroinvertebrate – *macro* means large, *invertebrate* means without a backbone. An invertebrate usually large enough to be seen without the aid of magnification.

Metamorphosis – *meta* means change, *morphe* means form. A change in form, structure or function as a result of development. A physical transformation undergone by various animals during development from the larval stage to the adult form. For example, through metamorphosis, a hellgrammite (larval form) becomes a Dobsonfly (adult form). The change from tadpole (larval form) to frog (adult form) is another example of metamorphosis.

Molecular Biology – the branch of biology 'hat deals with the chemical and physical composition, and the activities of the molecules of iving matter.

Mussel – any of the various freshwater or saltwater bivalves (meaning the two shells), held together by a strong muscle.

Non-permeable – not open to passage or penetration, especially by fluids.

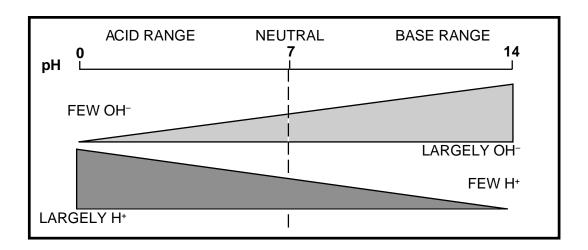
Nonpoint Source Pollution – pollution that cannot be traced to a specific point because it comes from many individual places or a widespread area (e.g., urban and agricultural runoff).

Nymph – the young of an insect that undergoes incomplete metamorphosis, differing from the adult primarily in size and structural proportions.

Organism – a plant or animal; any living thing.

pH – a measure of the power of the hydrogen ion (H⁺) activity in a substance.

pH Scale – a range of 0 to 14 used to measure the degree of acidity or basicity of a substance. A pH of 7 is neutral. See Acid and Base.



Photosynthesis – the chemical process carried on by green plants in which the cells that contain chlorophyll use light energy to produce glucose (a plant food) from carbon dioxide and water; oxygen is released as a by-product. See Respiration.

Plankton – collective term for the mostly microscopic plants (phytoplankton) and animals (zooplankton) that float or drift in oceans and fresh waters. These plants and animals are a very important food source in aquatic environments.

Point Source Pollution – pollution that can be traced to a single point source, such as a pipe or culvert (e.g., industrial and wastewater treatment plant discharges).

Pool – a deep still spot in a river, creek or stream.

Precipitation – a general term for all forms of falling moisture including rain, snow, hail or sleet.

Respiration – the process by which an organism takes in oxygen and releases carbon dioxide; breathing. See Photosynthesis.

Riffle – a shoal or gravel bar in a shallow part of a stream that produces a stretch of choppy ruffled water surface.

River Basin – the watershed of an entire river. It encompasses the many smaller watersheds of the river's tributaries or branches.

Runoff – rain, melted snow and other materials that drain or flow off surfaces such as city streets, roofs, suburban lawns and agricultural land.

Sediment – deposits of soil or organic matter that were suspended in water and then settled to the bottom. It is often deposited in the water by runoff.

Sedimentation – the deposition or accumulation of soil particles in water.

Sewage – liquid and solid waste mixed with water.

Soil – a collection of organic and inorganic particles, mainly composed of clay, silt, sand, and gravel.

clay - less than 1/256 of a millimeter (mm) in diameter

silt - between 1/256 and 1/16 of a mm in diameter

sand - between 1/16 and 2 mm in diameter

gravel - over 2 mm in diameter

Species – a biological classification of organisms. All organisms of a single distinct kind that have a high degree of similarity, and can mate and produce fertile offspring.

Stewardship – the act of people taking responsibility to maintain and protect a clean and healthy environment.

Stream Index Value – the relative health of a water body. It is based on the tolerance or sensitivity of a macroinvertebrate to changes in water quality and calculated using a simple formula.

Taxonomy – a system of arranging animals and plants into natural, related groups based on some factor common to each, such as structure, embryology, biochemistry, etc.

Threatened Species – a species that could become endangered in the future if it is not given some kind of protection.

Topographic – an accurate and detailed drawing of surface features of a particular region. These surface features include mountains, valleys, rivers, lakes, highways, bridges, etc.

Tributary – a stream or river flowing into a larger stream or river. The Eno River is a tributary of the Neuse River.

Turbidity – cloudiness caused by particles suspended in water.

Volume – a quantity, bulk, mass, or amount. The amount of space occupied in three dimensions.

Wastewater Treatment Plant – a facility where household, business and industrial sewage are treated to remove harmful bacteria and chemicals.

Water – a colorless, transparent liquid occurring on the earth's surface as rivers, lakes, oceans, etc. A chemical compound of hydrogen and oxygen, H₂O.

Water Treatment Plant – a facility where water is treated with chemicals, processed and distributed to homes, businesses and industries for drinking and other clean water uses.

Watershed – the total land area that drains directly or indirectly into a particular stream, river or lake.

Wetland – an area flooded by water frequently enough to support plants adapted to living in regularly or seasonally wet soil. Examples of wetlands are swamp forests, marshes, bogs, pocosins, beaver ponds and Carolina bays.

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SCHEDULING WORKSHEET

Date request r	eceived	Request received by	
l) Name of g	roup (school)		
2)Contact pe	erson		
	name	phone (work)	(home)
3) Day/date/t	ime of requested program	address	
3) Day/date/t	mie of requested program _		
4) Program d	esired and program length _		
5) Meeting p	lace		
6) Time of ar	rival at park	Time of departure f	rom park
7) Number of	7) Number of students Age range (grade)		
8) Number of	f chaperones		
9) Areas of s	pecial emphasis		
10) Special co	nsiderations of group (e.g. a	allergies, health concerns, phys	sical limitations)
		n park programs before? If yes	
If no, mail	the contact person an Educ		
	al permission forms require not, mail contact person a P	ed? If yes do they hearental Permission form.	have these forms?
		. — — — — — — — —	
	and agree to all the cond	, have read the entir litions within it.	e Educator's Guide and
Return to:	Eno River State Park		
Return to.	6101 Cole Mill Road		
	Durham North Carolin	na 27705	

PARENTAL PERMISSION FORM

Dear Parent:

Your child will soon be involved in an exciting learning adventure - an environmental education experience at Eno River State Park. Studies have shown that such "hands-on" learning programs improve children's attitudes and performance in a broad range of school subjects.

In order to make your child's visit to "nature's classroom" as safe as possible, we ask that you provide the following information and sign at the bottom. Please note that insects, poison ivy and other potential risks are a natural part of any outdoor setting. We advise that children bring appropriate clothing (long pants, rain gear, sturdy shoes) for their planned activities.

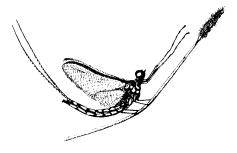
Child's name	
Does your child:	
Have an allergy to bee stings or insect bit	tes?
If so, please have them bring their medic able to administer it.	ation and stress that they, or the group leader, be
Have other allergies?	
-	ld be aware of?
• In case of an emergency, I give permission physician. I understand that I would be r	on for my child to be treated by the attending notified as soon as possible.
Parent's signature	date
Parent's name	Home phone
(please print)	Work phone
Family Physician's name	phone
Alternate Emergency Contact	
Name	phone

NORTH CAROLINA PARKS & RECREATION PROGRAM EVALUATION

Please take a few moments to evaluate the program(s) you received. This will help us improve our service to you in the future.

Date
ing and useful?
DRGANIZED YOUTH GROUPS
NAL QUESTIONS:
ılum needs?
i

Please return the completed form to park staff. Thank you.



Notes



Notes

